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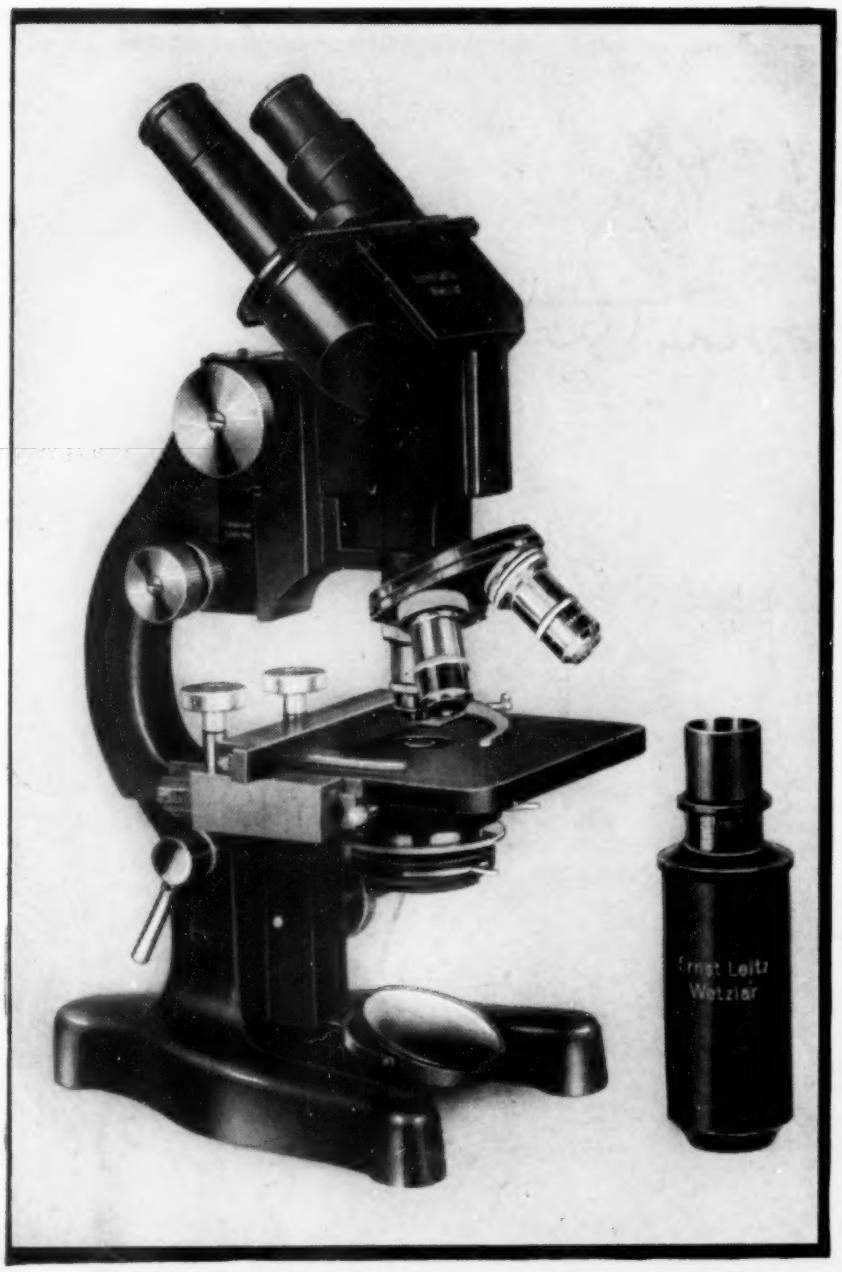

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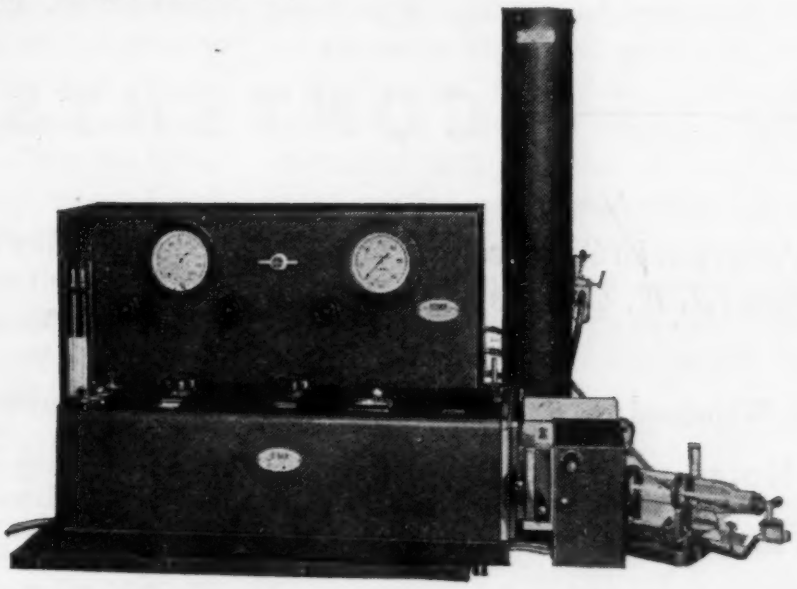

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A Federal Program in Applied Mathematics

J. H. Curtiss

National Applied Mathematics Laboratories, National Bureau of Standards, Washington, D.C.

THE GROWING IMPORTANCE OF MATHEMATICS, particularly applied mathematics, is one of the most significant trends in science today. This trend is part of a broader and necessary development in the physical sciences. Thus, the Steelman report (*1*) notes that the national research and development budget for the fiscal year 1947 in the physical and biological sciences alone was approximately $1,200,000,000, excluding expenditures for atomic energy. The Federal Government's share of this total was $625,000,000 of which $200,000,000 was spent in government laboratories. Even larger allocations for research and development are recommended for the future.

Because of the growing mathematical complexity of current problems in the physical sciences, the national research and development program carries with it substantial requirements for research and services in applied mathematics and related numerical techniques. This is particularly true in the case of the Government's part of the program, for at present a large fraction of it is concerned with the problems of national security, many of which are highly mathematical. Considerations of economy in Federal expenditures, on which so much emphasis is now properly being placed, add impetus to the full exploitation of the mathematical approach. Mathematical analysis prior to expensive laboratory experimentation or the construction of elaborate models is economical, both in actual costs and in the utilization of scientists.

Thus, even if no very remarkable developments were in sight in applied mathematics and related numerical techniques, there would be few arguments as to the importance of their place in the national scientific effort. As it happens, remarkable developments really are in sight in the field of numerical analysis. Automatic computing machinery is now being designed and constructed which will obtain numerical answers at amazing speeds. This machinery will not only greatly increase the effectiveness of the mathematical approach to standard problems, but will also permit successful attacks to be made on problems which have hitherto been considered to be inaccessible by mathematical methods. Examples of problems of the latter type arise in weather forecasting, in the rational planning of military and business operations, and in the automatic control of industrial processes.

The National Applied Mathematics Laboratories of the National Bureau of Standards have been recently established with the aim of strengthening the national applied mathematics effort. A particular concern of the new organization consists in promoting the rapid development of automatic computing machines and in taking steps to insure their most effective use when they become generally available.

Background and Motivation

"Applied mathematics" is not easy to define, and the term has different meanings for different persons. Work in applied mathematics is carried on largely at one or the other of two quite different levels, identified here as the research level and the level of applications of mathematics.[1]

The research level is characterized by complicated chains of original mathematical reasoning quite similar to those which characterize creative research in pure mathematics; but in applied mathematics the hypotheses and initial mathematical relationships are always intended to be approximate and abstract representations of some situation in another science, and conclusions are at once translated back into the language of that science. The main interest in the conclusions lies sometimes in the direction of predicting further experimental phenomena and sometimes in the direction of evaluating the practical validity of the hypotheses.

At the level of application of mathematics, the work consists in fitting already established (or trivially provable) mathematical propositions to situations in other sciences. The conclusions are again utilized at the research level.

In work at either level it is customary to require that conclusions be stated quantitatively, rather than qualitatively, so that a check against experimental data will be possible. Thus, the science of numerical analysis is frequently drawn upon by workers in applied mathematics. Accordingly, it has been customary to consider numerical computation, together

[1] This terminology was suggested by Mina Rees, head of the Mathematics Branch, Office of Naval Research.

with its theory and the related technology, as a companion-field to applied mathematics.[2]

In the United States, research in both pure and applied mathematics has been traditionally concentrated in educational institutions. Fortunately, there are now a number of lively centers of research in applied mathematics in such institutions. Most of them have been established within the last 10 years, and nearly all of them are able and willing to participate in the Federal scientific program through the medium of contracts. For example, centers for research in classical applied mathematics now exist at Brown University, Carnegie Institute of Technology, Massachusetts Institute of Technology, New York University, and a number of other universities. Additional centers for research in mathematical statistics have been established at Princeton University, Columbia University, the University of North Carolina, Iowa State College, and the University of California, among others. In addition, teams of research workers in applied mathematics have been organized at several of the government laboratories, notably at the Naval Ordnance Laboratory and the Aberdeen Proving Ground. The total effect has been to maintain research activities in this field at an intensity quite comparable to that of the wartime period.

At the level of applications, as contrasted with the level of research, the particular requirements of the Federal scientific program have been more difficult to meet. Some laboratories have successfully coped with their routine requirements in the application of mathematics by setting up jobs for one or two full-time consultants in applied mathematics. But the work load at any one laboratory is apt to be rather irregular, and, unfortunately, there are just not enough competent consultants to go around. There is, in particular, a scarcity of qualified consultants in the applications of mathematical statistics.

A somewhat similar situation exists in the field of numerical analysis. Many laboratories have set up computing facilities to meet routine requirements. However, if a computing group is small, the occasional large (and sometimes important) problem must be by-passed. If the group is a large one, there is usually a good deal of idle time due to irregularities of load. If the computing group is very large and has expensive automatic equipment, then the difficulty of recruiting competent programming personnel at the higher grades may seriously cut down the true maximum capacity of the group.

[2] It should be noted, however, that certain branches of pure mathematics, notably number theory, rely heavily on numerical computation, and most of the theory of numerical analysis itself is quite clearly a branch of pure mathematics. It therefore seems hardly possible to classify numerical computation simply as a subregion of applied mathematics.

This suggests that a limited centralization of computing facilities and consulting services at the level of the applications of mathematics would be profitable. The case for centralizing in a limited way is further strengthened when certain aspects of the new automatic computing machinery are considered. The present cost of a large-scale automatic digital computing machine is between $300,000 and $500,000. This is clearly beyond the resources of most of the university centers of applied mathematics, and every effort should be made to insure the widest possible availability of such costly machinery through centralization. Furthermore, the design and construction of such machines involve coordination problems of considerable magnitude. Large-scale computing machines have become the urgent concern of a number of different Federal agencies, and a central point of reference is needed to prevent unnecessary duplication of effort in the development program and to insure uniform quality. Since the maximum exploitation of such machinery will be heavily dependent on further research work in certain fields of pure and applied mathematics, it is the responsibility of any coordinating agency to promote such research to the utmost.

It seems apparent that there is a definite need for a central mathematical laboratory in the Federal scientific program. The organization should carry on a rather specialized set of activities chosen with the view of supplementing and supporting the existing research work in applied mathematics. The activities of the center could profitably include consulting services at the level of the applications and the production of aids for such consulting services (such as technical manuals), computing services and the production of aids to computations (such as mathematical tables), and a coordinated program of automatic computing machine development and research in associated branches of mathematics.

This need was the basis for the establishment of the National Applied Mathematics Laboratories as a division of the National Bureau of Standards.

Evolution of the Organization

The National Bureau of Standards had previously been active in the computing field for some years (1938–43) through its scientific sponsorship and administration of the Mathematical Tables Project in New York City. The Mathematical Tables Project started as a WPA project with a program of computing large tables of the basic mathematical functions. In 1943 its financial support was assumed by the OSRD, and it thereafter worked on some of the war problems of the Applied Mathematics Panel.

When OSRD support was withdrawn in the fall of 1946, the Office of Research and Invention of the Navy Department (now the Office of Naval Research) undertook temporarily to provide funds to resume the tabulations and continue the problem-solving work of the Tables Project. Some idea of the success of the tabulation work can be gained from the fact that in the period from 1940 to 1946 about 28,000 volumes of the tables (some of which contain several hundred pages of tabular material) were sold to the public, in addition to the free distribution to government laboratories and depositories. Several of the original editions of about 2,000 copies are now exhausted. The director of the Project since its inception has been A. N. Lowan.

Two other mathematical activities were initiated by the Bureau in the calendar year 1946. The writer was appointed as assistant to the director in April of 1946 and authorized to introduce mathematical statistical methodology into the routine work of the Bureau. The operating phases of the job were assigned later in the year to a group headed by Churchill Eisenhart. Shortly thereafter, the Bureau of the Census requested the Bureau to undertake the construction of a large-scale automatic digital computing machine suitable for the preparation of census reports and the performance of mathematical calculations arising in sampling surveys. Soon after this contract was accepted, the Army Ordnance Department transferred to the Bureau a substantial sum of money for research on electronic computer components, and the Office of Naval Research did likewise for the construction of a second large-scale automatic digital computing machine. Thus, the nucleus for a mathematics center of the type under discussion existed at the National Bureau of Standards by the end of the calendar year 1946.

Paralleling these developments was a movement within the Navy Department to foster the establishment of a national computing center. The idea seems to have originated in the Planning Division of the Office of Research and Invention. From the outset the recommendations of the Planning Division envisioned a center which not only would be equipped with high-speed automatic machinery (with emphasis on digital types) but also would assume leadership in the development of such machinery. Early in 1946 Rear Adm. H. G. Bowen, then chief of Naval Research, approached E. U. Condon, the director of the National Bureau of Standards, with a suggestion that the Office of Naval Research and the Bureau should jointly undertake to establish such a facility. A year of cooperative study and of consultation with various possible "clients" and applied mathematical groups ensued. The study clearly revealed the need for a Federal center of applied mathematics specializing in the types of activity identified in the preceding section as appropriate. Accordingly, the plans which finally emerged proposed that a facility with a mission considerably broader than that of a central computing laboratory should be established; further, that it should take the form of a new division of the National Bureau of Standards, but with an administration guided by a committee of representatives of various Federal agencies interested in the work of the center. The plan was presented in a widely distributed report (*2*), which received formal or informal concurrence from all officially interested groups.

It was agreed that the new unit would be called the National Applied Mathematics Laboratories, and the Laboratories were formally established as Division 11 of the National Bureau of Standards on July 1, 1947.

Description of the Laboratories

The scientific work of the National Applied Mathematics Laboratories is performed in the following four operating units: (1) *The Institute for Numerical Analysis,* at the University of California, Los Angeles; (2) *The Computation Laboratory,* at present in New York City; to be moved to the National Bureau of Standards, Washington, D. C., during the calendar year 1948; (3) *The Statistical Engineering Laboratory,* at the National Bureau of Standards, Washington, D. C.; (4) *The Machine Development Laboratory,* at the National Bureau of Standards, Washington, D. C.

In addition, there is an administrative office, located at the Bureau in Washington, which is responsible for program planning, the assigning of priorities, budgets, contracts, etc. Its decisions are subject to review by the director of the Bureau and are made with the guidance of a committee known as the Applied Mathematics Executive Council.

The Council is a committee of representatives of various operating agencies of the Government. The agencies initially represented on the Council were the Navy Department, the Department of the Army, the U. S. Air Force, the National Advisory Committee for Aeronautics, the Bureau of Agricultural Economics, the Bureau of the Census, and the Weather Bureau.

The total personnel complement of the National Applied Mathematics Laboratories is to be between 115 and 140. Annual operating costs, exclusive of capital costs and depreciation of equipment, are estimated at around $500,000. It might be mentioned here that this is only one-fourth of 1% of the total amount which, according to the previously cited report of the President's Scientific Research Board, is being spent during the fiscal year 1947 in govern-

ment laboratories, and less than one-twelfth of 1% of the total Federal research and development budget as given by that report.[3]

It will be noticed that the locations chosen for the units of the Laboratories are restricted to Washington and Los Angeles. In making this choice, the three determining considerations were proximity to immediate sources of problems, ease in recruiting personnel, and continuity of the already existing mathematical activities of the Bureau. The problems worked on by the Mathematical Tables Project have originated almost entirely in the East, particularly in and around Washington, D. C. Of all the areas west of Washington, the Southern California area, with its extensive contract-supported, guided-missile development work and its large government laboratories, seemed to be the region most likely to make good use of a branch of the Laboratories. The Air Materiel Command of the U. S. Air Force particularly favored the Los Angeles location, and the highly cooperative attitude of the personnel of the University of California at Los Angeles (in particular, that of the provost, C. A. Dykstra) was another decisive factor. If further expansion of the Laboratories is justified at some future date, the desirability of placing further branches in the Middle West and elsewhere will be given serious consideration.

The Institute for Numerical Analysis

Section 1, the Institute for Numerical Analysis, is the focal point in the organization for basic research and training in the types of mathematics which are pertinent to the efficient exploitation and further development of high-speed automatic digital computing equipment. A secondary function is to provide a computing service for the southern California area and to give assistance in the formulation and analytical solution of problems in applied mathematics. It will be equipped with one general-purpose automatic electronic digital computing machine and with the usual desk calculators and punch-card equipment. The automatic computing machine will probably be supplied by the Air Materiel Command of the U. S. Air Force. It is hoped that this machine, which is now being developed in Section 4, the Machine Development Laboratory, will be delivered on or about January 1, 1949.

The research program will depend in part on the personnel at the Institute. The intention is to maintain a small, permanent staff at the top research levels and to carry on most of the work through temporary appointments of strong research men on leave of absence from their regular places of employment. In addition, the Institute will provide facilities for visiting scholars to investigate and develop in their own special fields of research the mathematical techniques studied by the Laboratories. A percentage of the time of the automatic computing machine will be reserved for purposes of mathematical research, as opposed to service computations. The original plans for the Institute called for a personnel complement of about 40 persons, including part-time workers. (It is expected that some of the training functions will be discharged by employing graduate students part time.)

The research program has been underwritten for 1947–48 and 1948–49 by the Office of Naval Research. The Air Materiel Command of the Air Force is at present the principal supporter of the computing service. Operations commenced in January 1948 in a temporary building. Permanent quarters will later be furnished on a rental basis by the University in a new engineering quadrangle now under construction.

The Computation Laboratory

Section 2, the Computation Laboratory, consists chiefly of the old Mathematical Tables Project with some strengthening at the top. The chief mission of the Computation Laboratory is to provide a general computing service of high quality and large capacity. A function of almost equal importance is the continuation of the series of tables of the Mathematical Tables Project. Services are also offered in analytical applied mathematics at the level of the applications, and a considerable amount of research is performed on the classical theory of numerical analysis. The Computation Laboratory will be equipped with at least one, and perhaps two, general-purpose, automatic-sequenced computing machines. The machine now earmarked for the Computation Laboratory is the one being developed by Section 4 for the Office of Naval Research. It may be ready for operation sometime on or about January 1, 1949.

The general scope of the work of the Computation Laboratory can be indicated by a brief résumé of the work performed during the three-month period from July 1 to September 30, 1947.

A table (3,000 entries) of mutual impedances of metal detector head coils from Wheatstone bridge arm data was prepared for the laboratories of the Engineer Corps at Fort Belvoir, Virginia. Tables of a two-parameter integral arising in antenna theory were prepared by mechanical quadrature for the Naval Research Laboratory, Anacostia, Maryland. The difference in the lattice sums of the third order Van der Waals interaction for the two closest packed lattices

[3] It should be re-emphasized here that the report excludes expenditures for atomic energy and pertains only to the physical and biological sciences.

the hexagonal and face-centered cubic) was computed for a research project in the physics of solids under way at the Bureau. A long series of computations relating to 9 given matrices arising in the theory of atomic spectra were carried out for another Bureau project; the computations involved solution of the secular equations and of systems of related linear equations. Third-degree, two-variable surfaces of constant barometric pressure were fitted by least squares to climatological data arising in the meteorological study under way at New York University and the Institute for Advanced Study in Princeton. Work was continued on a large, two-volume table of the Mathieu Functions. A nearly complete table of Bessel Functions of fractional orders was checked by differencing. A nonlinear partial differential equation arising in heat conduction theory was solved for various boundary conditions. Work was performed on large tables of the Coulomb Wave Functions, of the exponential integral, of the Bessel Functions $Y_0(z)$ and $Y_1(z)$, of trigonometric functions to a hundredth of a degree, of 10^x to 10 decimal places, of spheroidal wave functions, of Jacobi Elliptic Functions, and of Gamma Functions for complex arguments. Ordinary differential equations arising in guided missile work and in the study of the effect of centrifugal forces on the human body were solved. Systems of simultaneous equations containing 46 unknowns arising in the theory of logistics were solved. Various integrals involved in the theory of atomic spectra and electronics were evaluated by numerical methods.[4]

The personnel complement of the Computation Laboratory is between 60 and 70. The Office of Naval Research is currently supplying the major part of the operating funds, the Hydrographic Office of the Navy Department and the National Bureau of Standards also contributing a share.

The Statistical Engineering Laboratory

Section 3, the Statistical Engineering Laboratory, provides a general consulting service on methods of modern statistical inference as applied to the engineering and physical sciences. Basic research in statistical theory and the formulation of requirements for new statistical tables, which are then computed in Section 2, are also undertaken.

Until the present, this Laboratory has devoted its attention chiefly to other divisions of the National Bureau of Standards and to the Federal Specification Board. In the routine testing and calibration activities and engineering experiments of the Bureau there are practically endless opportunities for the application of mathematical statistics, and a much larger group than the unit of about 10 persons originally provided for in the plans for the statistical laboratory could profitably be employed on Bureau work alone. A controlling factor in the expansion of the laboratory is the difficulty of obtaining qualified personnel at the higher levels. In spite of the limited capacity of the present unit, it is expected that an increasing amount of the energies of the Laboratory will be devoted in the future to problems originating outside of the Bureau.

The Machine Development Laboratory

Section 4, the Machine Development Laboratory, consists at present of a mathematics group of 5 under the direct administration of the National Applied Mathematics Laboratories and an engineering group of 15 at present being administered by the Ordnance Development Division of the Bureau. Technically, the two groups operate as a single unit. The primary function of this Laboratory is to develop and supervise the construction of automatic computing machines which will meet performance specifications established by other sections of the National Applied Mathematics Laboratories and by outside agencies. The Laboratory also develops standards of performance and specifications for computer components, such as arithmetic units, input devices, memory devices, and electronic tubes.

Present emphasis is entirely on high-speed automatic electronic digital computers; no attention is being paid to the analogue types of device such as the differential analyzer. Detailed design specifications have already been established for automatic computers for the Bureau of the Census, the Office of Naval Research, and the U. S. Air Force. Several alternative designs, two of which were produced by contractors working directly for the Machine Development Laboratory, are now beng evaluated with the assistance of the Committee on High-Speed Calculating Machinery of the National Research Council. Construction of the machines themselves is expected to start early in 1948. Another important project has consisted of the research and development in components, performed for the Office of the Chief of Ordnance. This project has resulted, among other things, in the preparation of data transducers and verifiers for the EDVAC machine being built by the Moore School of Electrical Engineering for the Aberdeen Proving Ground and for the machine being developed under J. von Neumann at the Institute for

[4] The details of these projects will be forwarded upon application to the Chief, National Applied Mathematical Laboratories, National Bureau of Standards, Washington 25, D. C. The Computation Laboratory issues monthly progress reports which will be sent regularly to any interested scientist upon request.

Advanced Study in Princeton, New Jersey, with the cooperation of the Radio Corporation of America.

A very important part of the work of the Machine Development Laboratory consists in acting as a coordinating agency and an information exchange center for the Federal automatic digital computer program. To this end, bibliographies have been prepared and distributed, and an information and discussion section for the journal *Mathematical Tables and Other Aids to Computation* (published by the National Research Council) is being compiled and edited.

Much of the program of the National Applied Mathematics Laboratories (with the exception of that of the Statistical Engineering Laboratory) is not strictly classifiable as "applied mathematics" at all, since it is concentrated in the near-by field of numerical analysis. The immediate reason for this phenomenon should be apparent from the background and history of the organization. It is interesting to note in this connection that, some three years ago, a mathematical organization with a similar program and setting was established in England as the Mathematics Division of the National Physical Laboratory. Other countries are also setting up national mathematical centers with emphasis on computing an automatic computer development.

However, there is considerable reason to believe that as the National Applied Mathematics Laboratories mature and, in particular, as automatic equipment now under development comes into actual use in the Laboratories, the program will tend to conform more and more closely to a puristic interpretation of the name of the organization. Even now, plans are being made for a further strengthening of the work at the level of the applications of mathematics. Traditionally, a certain amount of basic research in applied mathematics has been carried forward in various scattered groups in the National Bureau of Standards, and it may be that later on a special section should be added to the Laboratories to consolidate and extend this activity. In the meantime, there is much to be done in the present areas of concentration of the work of the Laboratories, and it is believed that a substantial contribution to the national scientific effort will be made if the present program is effectively carried out.

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Obituary

Alfred North Whitehead

1861-1947

Alfred North Whitehead died in Cambridge, Massachusetts, on December 30, 1947. He was born in Ramsgate, England, on February 15, 1861.

He attended Trinity College, Cambridge, where he obtained the B.A. degree in 1884, the M.A. degree in 1887, and the D.Sc. in 1905. He also received the D.Sc. degree from the universities of Manchester, Harvard, Wisconsin, Yale, and McGill and an LL.D. from St. Andrews.

He was lecturer and later senior lecturer on mathematics in Trinity College, Cambridge, from 1885 to 1911; lecturer on applied mathematics and mechanics and later reader in geometry at University College, University of London, 1911–14; professor of applied mathematics and later chief professor of mathematics, Imperial College of Science and Technology, University of London, 1914–24; dean of the Faculty of Science, 1921; professor of philosophy, Harvard University, 1924–36; and professor emeritus, 1936 to the time of his death. He was a Fellow of the Royal Society and the British Academy and a member of the Mathematical Society, the British Association for the Advancement of Science, the Aristotelian Society, and the American Philosophical Association. He received the James Scott Prize from the Royal Society of Edinburgh in 1922, the Sylvester Medal from the Royal Society of London in 1925, and the Order of Merit in 1945.

His publications include *A treatise on universal algebra,* 1898; *Principia mathematica* (with Bertrand Russell), 1910; *An introduction to mathematics,* 1910; *The organization of thought,* 1916; *The principles of natural knowledge,* 1919; *The concept of nature,* 1920; *The principle of relativity,* 1922; *Science and the modern world,* 1925; *Religion in the making,* 1926; *Symbolism: its meaning and effect,* 1927; *The aims of education,* 1928; *Process and reality* (the Gifford Lectures) and *The function of reason,* 1929;

Adventures of ideas, 1933; *Nature and life,* 1934; and *Modes of thought,* 1938.

Few men since Leibnitz and Aristotle have touched so many fields with such originality, precision, and profundity. His *Principia mathematica,* written with Bertrand Russell, formulates deductively the modern theory of mathematics and formal logic after the manner in which Newton gave the first deductive formulation of modern physics. From mathematics proper he moved to the problem of the relation of mathematics to physics. He saw that Einstein's theory of relativity entailed not merely a reconstruction in our scientific and philosophic conceptions of space and time but also a reconstruction in the conception of the relation of scientific objects to space and time—a reconstruction which requires a completely new theory of what a scientific object is and what its relation is to the deliverances of sense awareness with which all scientific and philosophical knowledge begins. It was the latter type of inquiry, pursued in *The principles of natural knowledge, The concept of nature,* and *The principle of relativity,* which convinced Whitehead that a reconstruction in the basic concepts of philosophy is necessary even to achieve the required reconstruction in the concepts and methods of physics. This prepared the way for the acceptance of a call to the Department of Philosophy, Harvard University.

Although Whitehead was never trained professionally as a philosopher, he knew his Plato, Aristotle, Descartes, Locke, Berkeley, Hume, Leibnitz, Kant, Bradley, and James. This acquaintance with Western philosophy as well as mathematical physics enabled him to see that the basic difficulties in contemporary psychological and philosophical theory center in errors made at the very beginning of the modern world and that, as a consequence, contemporary problems can be solved, not by patching up or reconstructing recent traditional modern scientific and philosophical theories, but only by going back to the origins of modern scientific and philosophical thought to remove an initial error. He saw also that this error was introduced, not by the philosophers, but by the scientists, in particular by Galilei and Newton.

This error he located in the distinction first made by Galilei and later repeated by Newton between (a) apparent sensed qualities in apparent relative sensed space and time and (b) public or "real" scientific objects in "true, real, and mathematical" space and time. It is to be noted that this distinction introduced by Galilei and Newton involves two different assumptions: (1) the thesis that (a) scientifically conceived, indirectly observed, experimentally verified nature is not identical with (b) directly observed sensed nature, and (2) the theory that (a) is related to (b) by a three-termed relation of appearance in which the observer is the third, mediating term between (a) and (b).

The latter assumption necessitates the identification of the observer with Locke's mental substance. Forthwith all the subsequent theories of modern philosophy and psychology are generated, each one of which gets into difficulties with certain facts.

Whitehead's solution consisted in rejecting the first of the two assumptions of Galilei and Newton. The second one then becomes unnecessary, and Locke's dismissal of mind from nature ceases to be required. This rejection of the initial assumption appears in Whitehead's attack upon what he called "the bifurcation of nature."

This forced him to derive the concepts of mathematical physics from sensed nature. In order to do this, a new scientific method was required. This he called "the method of extensive abstraction." Its application results in the entities and relations of nature being quite different from those of traditional modern science or philosophy. The working out systematically of the new foundations for both science and philosophy which such a procedure entails becomes the topic of Whitehead's most mature and systematic work, his *Process and reality.* The new philosophical standpoint which it expresses is then pursued in the humanistic field in his later works.

Scientists, in reflecting on Whitehead's work, will eventually return to the problems concerning rotational motion raised by the acceptance of Einstein's theory of relativity. Whitehead saw very early that the explanation of rotational motion and the Foucault pendulum experiment by Mach's hypothesis, to which Einstein's treatment of rotational motion resorts, is by no means necessary or very satisfactory. Few people have seen these particular difficulties and the other basic problems on the frontier of 20th-century scientific and philosophical thought more clearly than did Whitehead. He made it clear that there is an essential connection between mathematics and logic and between science and philosophy.

F. S. C. NORTHROP

Yale University

NEWS and Notes

The winners of the Seventh Annual Science Talent Search were announced at a banquet given in their honor on March 2 at the Statler Hotel, Washington, D. C. The boy and girl receiving grand prize scholarships of $2,400 are pictured on this week's cover being congratulated by W. W. Waymack, of the U. S. Atomic Energy Commission, who was the speaker on this occasion. In competition for the awards, Barbara Claire Wolff (*left*), of the Forest Hills High School, New York, had presented the results of her experiments in producing phenocopies in fruitflies, and Andrew Steven Kende (*center*), of Evanston Township High School, Illinois, had described his research leading to the preparation of less flammable Grignard reagents. Alternates selected for these awards were Laura Caroline Maurer, of the South Side High School, Rockville Centre, New York, and Kurt William Kohn, of the Bronx High School of Science, New York City.

The 40 high school students brought to Washington, D. C., to participate in the Seventh Annual Science Talent Institute from February 27 to March 2 were selected by judges from 16,421 contestants, 3,161 of whom completed entries by taking a science aptitude examination, obtaining recommendations, and writing an essay on "My Scientific Project." Entries were received from every state. During their five-day visit the national winners made trips to local institutions and laboratories and heard talks on various aspects of science by distinguished scientists. The scholarship awards were based on the recommendation of the judges' panel consisting of Harlow Shapley, Rex E. Buxton, psychiatrist, and Harold E. Edgerton and Steuart Henderson Britt, psychologists.

The national winners receiving $400 science scholarships were: Laura Caroline Maurer; Igor Alexeff, Mt. Lebanon High School, Pittsburgh; Gene Allen Baraff, Forest Hills High School, New York; Gerald Leonard Howett, Abraham Lincoln High School, Brooklyn; Alan Robert Johnston, Van Nuys High School, California; Kurt William Kohn; Alan Richard LeSchack and Gerhard Rayna, both of the Stuyvesant High School, New York City; R. Daniel Rigal, Liberty Center Village High School, Ohio; and David Andrew Yphantis, Public Latin School, Boston. Alternates were Stanley Harris Zisk, Public Latin School, Boston; David Melville Geller, Oak Park Township High School, Illinois; and Lawrence Joseph Schaad, Logan High School, Ohio. The 28 participants not listed above received $100 science scholarships.

The Science Talent Search is conducted each year under the sponsorship of the Science Clubs of America through funds provided by the Westinghouse Educational Foundation.

About People

George E. Raynor, professor of mathematics at Lehigh University, will become head of the department July 1. Dr. Raynor will succeed **Joseph B. Reynolds,** who will retire June 30 after 41 years of service.

Allan G. Newhall, professor of plant pathology, Cornell University, will soon complete a sabbatical leave of 6 months at the Inter-American Institute of Agricultural Sciences, Turrialba, Costa Rica, where he is carrying on research on cacao diseases.

John T. Rettaliata, director of the Department of Mechanical Engineering at Illinois Institute of Technology, will become dean of engineering next September 1. Dr. Rettaliata will fill the position vacated by **James C. Peebles,** who retires in August.

Sol Pincus, formerly sanitary engineer with the U. S. Public Health Service and more recently deputy commissioner and senior sanitary engineer with the New York City Department of Health, has opened offices for the practice of sanitary engineering and for public health investigations and reports at 11 Park Place, New York 7, New York.

Jacob B. Biale, assistant professor of subtropical horticulture, University of California, Los Angeles, has been granted a six-month leave of absence to study recent European developments in problems of plant and animal respiration. Dr. Biale has received invitations to visit the biochemistry laboratory at Sheffield University and the low-temperature research station at Cambridge, England, the Biochemistry Institute in Stockholm, and the Weizmann Institute of Science at Rehovoth, Palestine.

Leo R. Tehon, head of the Section of Applied Botany and Plant Pathology, Illinois State Natural History Survey, has been appointed professor of plant pathology in the Graduate College, University of Illinois. Dr. Tehon will continue, however, in his present position with the Survey.

Colleges and Universities

The First Louis Slotin Memorial Lecture was given at the University of Chicago today by S. E. Luria, associate professor of bacteriology at Indiana University. The subject was "Radiobiological Studies on Viruses." This lectureship has been provided by friends of the late Dr. Slotin, University of Chicago physicist, who lost his life while working at Los Alamos.

Pennsylvania State College has established a Department of Chemical Engineering, with D. S. Cryder acting as its head.

The new low-temperature laboratory at Rutgers University is to have as part of its equipment a 6-ton electromagnet just completed by General Electric. The huge device is 56″ long, 39″ wide, and 20″ high. The two coils are 36″ in diameter. Main body of the instrument, made of iron, weighs 10,000 pounds, and the copper-wire coils weigh 1,000 pounds each. In spite of its size, the electromagnet is precision built, pole faces deviating from being perfectly parallel by only one-sixth the thickness of

an average sheet of paper. Although not designed for lifting purposes, the magnetic force is equivalent to about 40,000 pounds. The electromagnet will be used at Rutgers in experiments requiring generation of extremely strong magnetic fields over large areas. The instrument should provide a means for reaching temperatures in the range of absolute zero. It will also be used to study magnetic susceptibility at low temperatures as well as to investigate nuclear magnetic properties of isotopes.

New York University-Bellevue Medical Center is currently presenting a series of weekly broadcasts—The Doctors' Round Table—devoted to discussions of current health topics by medical leaders. These broadcasts are carried over the facilities of station WMCA from 9:45 to 10:00 P.M. On March 17 and 24 the discussions will deal with "Atomic Medicine," with R. Keith Cannan, chairman of the Department of Chemistry, New York University College of Medicine, and guests from scientific organizations working with atomic energy participating. Announcements of future broadcasts will be made as received.

The Faculty of Medicine, Harvard University, announces that three lectures on "Aspects of Microbial Physiology," under the Edward K. Dunham Lectureship for the Promotion of the Medical Sciences, will be presented on March 22, 24, and 26 at 5:00 P.M. at the Harvard Medical School Amphitheater, Building E. André Lwoff, head of the Department of Microbial Physiology, Institut Pasteur, Paris, will deliver the lectures.

Summer Programs

A geology field session will be conducted by the Department of Geology, University of New Mexico, from June 12 to August 7. The session will be held at La Madera Ski Area, in the Sandia Mountains, 29 miles east of Albuquerque, at an elevation of 8,600′. The camp's four dormitories accommodate 64 students (men and women). Hot showers, sanitary plumbing, and electric lights add to the comfort of the camp. The central lodge serves as class-room, study hall, and recreation room.

Courses in elementary and advanced field geology, structural geology, geomorphology, and field problems will be offered.

The geology of the area is varied. The Sandia Mountains are a classical example of a tilted fault-block of the Basin and Range type. The area affords an excellent opportunity to study igneous, sedimentary, and metamorphic rocks ranging in age from pre-Cambrian to Recent. The igneous rocks consist of a pre-Cambrian granite batholith, early Tertiary monzonite sills and laccoliths, and later latite and andesite dikes. There is a nearly complete sedimentary section consisting of marine and continental sediments and ranging from Pennsylvanian to Pliocene in age in the area. The pre-Cambrian terrane also consists of regionally metamorphosed schist, gneiss, quartzite, and greenstone. Thermally metamorphosed limestones border the early Tertiary laccoliths and sills. A wide variety of fold and fault structures exists in the area. Mineral deposits consist of copper, gold, lead, zinc, fluorspar, barite, turquoise, and coal.

The teaching faculty will be Vincent C. Kelley, Carl W. Beck, and Sherman A. Wengerd, all of the Department of Geology.

Further information and applications may be obtained from Prof. Beck.

The Mt. Desert Island Biological Laboratory's summer program, as previously announced (*Science*, February 6, p. 137), referred to the Tissue Culture Program, to be directed by Philip R. White, Institute for Cancer Research, Girard and Corinthian Avenues, Philadelphia 30. Dr. White has informed us that the laboratory will accommodate about 10 investigators with research problems in the field of aseptic cultivation of tissues, organs, and embryos of plants and animals. Preference will be given to projects utilizing local organisms, and only applicants qualified to carry on independent research will be accepted. The laboratory fee will be $100 per person for any part of the season (June 15–September 15). Applications should be sent immediately to Dr. White.

Industrial Laboratories

Gustavus J. Esselen, president of the Esselen Research Corporation, Boston, last month received the first James F. Norris award at the 50th anniversary dinner of the Northeastern Section of the American Chemical Society. The annual award, in memory of the late Prof. Norris, of Massachusetts Institute of Technology, was presented to Dr. Esselen for his contributions to the advancement of the Section.

Weather scientists at General Electric's Research Laboratory have developed an instrument that records the geometric shapes, sizes, and frequency of occurrence of snow crystals falling during a storm. When used along with other devices, the snow-crystal recorder is helping to determine how a snowstorm affects brightness of sky and flow of electric current from the atmosphere to the ground. The automatically operated instrument is set up in an exposed position, the flakes being allowed to fall on a 6″ by 4″ area of special paper coated with water-soluble dye for one minute at 15-minute intervals. Because of a small amount of heat applied under the paper, the flakes melt at once, leaving dark blue impressions. Thus, a biography of a storm is "written." The instrument was developed by Vincent J. Schaefer, Raymond E. Falconer, and William Kearsley, in connection with the program on fundamental weather research being conducted by G–E for the U. S. Army Signal Corps and ONR.

Wilbur A. Lazier, director of the Southern Research Institute for the past three and one-half years, will become director of Chemical Research for Chas. Pfizer & Co., Inc., of Brooklyn, New York, on April 1, 1948. During his professional career, Dr. Lazier has been associated principally with the synthetic organic chemical industries.

Meetings

The largest radio engineering show in history will be held in conjunction with the 1948 annual convention of the Institute of Radio Engineers, March 22–25, at the Hotel Commodore and Grand Central Palace, in New York City. Theme of both convention and show is "Radio-Electronic Frontiers." A total of 130 papers will be presented in the 26 sessions which have been arranged. These sessions will cover such topics as Frequency Modulation, Systems, Navigation Aids, Antennas for Circular Polarization, Amplifiers, Passive Circuits, Tube Design and Engineering, Super-regeneration, Transmission, Nuclear Studies, Industrial Applications and Electronic Circuits, Components and Supersonics, Television, Tube Manufacture, Measurements, Computers, Broadcasting and Recording, Propagation, Microwaves, Receivers, and Active Circuits. In addition, there will be two special symposia on "Nucleonics" and "Advances Significant to Electronics."

The New York Section of the International Association for Dental Research will meet at the Guggenheim Dental Clinic, 422 East 72nd Street, New York City, on April 29 at 8:30 P.M. Information regarding the program may be obtained from Isaac Neuwirth, Secretary, College of Dentistry, New York University, 209 East 23rd Street, New York 10.

The American Association on Mental Deficiency is holding its 1948 annual meeting at the Copley-Plaza Hotel in Boston, May 18–22. The meeting commemorates the 100th anniversary of the first school for mental defectives in this country.

The International Society of Hematology will hold its biannual meeting at the Hotel Statler, Buffalo, New York, August 23–26, 1948. Half-days have been tentatively allotted for general subjects, including radioactive and stable isotopes in hematology; for problems and diseases related to the red cells; for problems and diseases related to the white cells; for coagulation problems and hemorrhagic diseases; and for the business meeting. One day will be devoted to immunohematology, Rh-Hr (CDE-cde) antigens and antibodies, and hemolytic anemias.

Scientific exhibits will be presented in the south wing of the Statler's 17th floor. Applications for the presentation of such exhibits are now being received by O. P. Jones, Department of Anatomy, University of Buffalo, Buffalo, New York. Chairman of the Program Committee is Ernest Witebsky, Buffalo General Hospital, Buffalo, New York.

Eduardo Uribe Guerola, Leibnitz #212, Nueva Colonia Anzurez, Mexico, D.F., and Sir Lionel Whitby, University of Cambridge, Cambridge, England, are in charge of arrangements for the programs from South and Central America and Europe, respectively. Communications concerning applications for the program will be received by the above-named committeemen.

All scientific sessions and exhibits will be open to scientists interested in hematology. This will, of course, include members of the medical profession and those branches of science dealing with hematology, such as biochemistry, biophysics, genetics, immunology, etc.

Communications and applications concerning membership will be received by the following members of the Membership Committee: William Dameshek (chairman), 25 Bennett Street, Boston, Massachusetts, for U.S.A.; M. Bessis, Laboratoire de Recherches du Centre National de Transfusion Sanguine, 53, Boulevard Diderot, Paris, France; Robert R. Race, Lister Institute, Chelsea Bridge Road, London, S.W. 1, England; Ludwik Hirszfeld, Institute of Medical and Microbiological Science, Wroclaw, Poland; Ignacio Gonzales Guzman, University of Mexico, College of Medicine, Mexico, D.F.; Walter Cruz, Instituto Oswaldo Cruz, Caiza Postal 926, Rio de Janeiro, Brazil; Alfredo Pavlovsky, Ancherena 1710, Buenos Aires, Argentina; Theodore Waugh, McGill University, Montreal, Quebec; Berger Broman, Royal Caroline Medical School, Stockholm, Sweden; C. R. Das Gupta, Calcutta School of Tropical Medicine, Calcutta, India; Luis Sandoval S., Instituto de Histologia de la Universidad de Concepcion, Santiago, Chile; Rod Sirivejkul, Army Medical Department, Bangkok, Siam; Carl Rohr, Medizinischen Universitätsklinik, Zurich, Switzerland; Moises Chediak, Laboratories Chediak, 23 #654 Esq. A., Banos Vedado, Havana, Cuba; G. di Guglielmo, Director of Medical Clinics, University of Naples, Policlinico, Naples, Italy; and Henrik Dam, Danmarks Tekniske Hojskole, Biologisk Afdeling, Ostervolgade 10″ Trappe L, Copenhagen, Denmark.

Those interested in attending the meetings may communicate with Sol Haberman, Secretary, The William Buchanan Blood Center, Baylor Hospital, Dallas, Texas.

American geologists who wish to attend the International Geological Congress in Great Britain, August 25–September 1, and who have had difficulties in obtaining passage by ship will be pleased to know that the general secretary of the Congress has been assured by both Cook's Tours and Cunard White Star that everything possible will be done to accommodate members of the Congress. Even though an applicant is not assured of a specific sailing date at the time of application, there is no doubt that he will eventually be provided with a berth at about the time specified. In addition to shipping difficulties, some prospective Congress members may feel that they should not partake of the reportedly meager food supplies in England. Those planning the Congress have done everything possible to provide for the comfort and feeding of Congress members and indicate that conditions are less rigorous than reports abroad may suggest. Special local hospitality is also planned for the excursion parties by civic authorities, industrial firms, and other groups. It is emphasized that the success of the Congress will depend in large measure upon the presence of the approximately 500 U. S. and Canadian members (and relatives) who provisionally registered in response to the Third Circular.

The Botanical Society of America, Inc., will hold its annual meeting and program in Washington, D. C., over

the weekend preceding the Centennial Celebration of the AAAS, which will be held September 13–17. The exact dates of the Society's meetings have not been definitely settled, but it is probable that they will run from September 10 to 13, inclusive. Joint sessions with the Mycological Society of America, American Society of Plant Taxonomists, Genetics Society of America, and the Ecological Society of America are being planned as in previous years.

Complete details of this meeting will be sent to members of the Society later in the spring. Members who desire to present papers at this meeting are requested to bear in mind that the *deadline for titles and abstracts of papers is July 15.*

The last annual meeting of the Society was held December 26–30 in Chicago. Officers for the present year are: Henry A. Gleason, New York Botanical Garden, president; Adriance S. Foster, University of California, vice-president; Ralph B. Cleland, Indiana University, new member of Editorial Board; John S. Karling, Columbia University, secretary; Truman G. Yuncker, DePauw University, treasurer; and Ronald Bamford, University of Maryland, business manager. At the December meeting the Society elected four foreign botanists as Corresponding Members: Harald Kylin, Lund University, Sweden; C. D. Darlington, director of the John Innes Horticultural Institution, Merton, London; Birbal Sahni, University of Lucknow, India; and Rene Vandendries, L'Athenée Royale, Belgium.

NRC News

John S. Nicholas, director of the Osborn Zoological Laboratory and Sterling professor of biology at Yale University, has been appointed chairman of the Council's Division of Biology and Agriculture.

An American Institute of Biological Sciences was formally established on Friday, February 20. The rapid advance of the biological sciences and their impact on human welfare have created new problems relating to the development and application of those sciences. During recent years many biologists have recognized that the biological sciences have suffered from the lack of a service organization which would enable the various biological societies to discharge more effectively those functions which are of common concern to all but which individual societies cannot exercise adequately. The new Institute is designed to fill this need and to serve in other ways.

Recognizing the potential importance of the new undertaking for the advancement of the biological sciences and, through them, for all biologists, the NRC has endorsed the program and agreed to make its general services available. As a part of the NRC, the Institute will, in addition, provide biologists with an agency through which they can maintain close relations with government activities and with other fields of science represented within NRC. The announcement stresses, however, that affiliation with NRC will preclude any lobbying activities on the part of the Institute.

Twelve societies and the NRC named directors to the Governing Board, as follows: American Physiological Society, W. O. Fenn; American Society for Horticultural Science, F. P. Cullinan; American Society of Parasitologists, W. W. Cort; American Society of Plant Physiologists, F. W. Went; American Society of Zoologists, C. W. Metz; Botanical Society of America, R. E. Cleland; Genetics Society of America, P. C. Mangelsdorf; Limnological Society of America, Charles Mottley; Mycological Society of America, F. D. Kern; Poultry Science Association, T. C. Byerly; Society for the Study of Development and Growth, B. H. Willier; Society of American Bacteriologists, L. W. Parr; and NRC, E. G. Butler, R. F. Griggs, H. B. Steinbach, and Paul Weiss.

Other societies considering joining the Institute appointed observers: American Association of Anatomists, R. L. Zwemer; American Association of Economic Entomologists, B. A. Porter; American Genetics Association, R. C. Cook; American Phytopathological Society, J. C. Walker; American Society of Animal Production, R. W. Phillips; American Society of Biological Chemists, Dean Burk; American Society of Ichthyologists and Herpetologists, K. P. Schmidt; American Society of Mammalogists, Remington Kellogg; Ecological Society of America, W. A. Dayton; National Association of Biology Teachers, Oscar Riddle; Society of American Foresters, Henry Clepper; The Wildlife Society, L. J. Bennett.

The Governing Board elected the following officers and Executive Committee: R. E. Cleland, Indiana University, chairman; E. G. Butler, Princeton University, vice-chairman; W. O. Fenn, Rochester, New York, member for three years; T. C. Byerly, Bureau of Animal Industry, USDA, member for two years; and F. P. Cullinan, Bureau of Plant Industry, USDA, member for one year. Ex-officio members are D. W Bronk, chairman of NRC, and J. S. Nicholas, chairman of the Division of Biology and Agriculture.

Deaths

Raphael Eduard Liesegang, 78, died in Bad Homburg, v.d.H., Germany (American Zone), on November 13, 1947. Dr. Liesegang who was a scientific member of the Kaiser-Wilhelm-Instituts für Biophysik and director of the Instituts für Kolloidforschung at Frankfurt, is known for his discovery of periodic precipitation in gels.

Gerald B. Webb, 76, president of the Colorado Foundation for Research in Tuberculosis at Colorado College, died January 27 in Colorado Springs.

William R. Maxon, 70, former curator of the National Herbarium of the Smithsonian Institution and former editor-in-chief of the *American Fern Journal,* died February 27 in Terra Ceia, Florida.

Edward A. Balloch, 91, dean emeritus of the Howard University Medical School, died March 2 in Washington, D. C.

A. A. Brill, 73, former president of the American Psychoanalytic Association and lecturer at Columbia University, died March 2 in New York City. Many works of Sigmund Freud, under

whom he had studied, as well as of Carl Jung, were first translated into English by Dr. Brill.

Illo Hein, 54, former professor of botany at Pennsylvania State College and more recently cytologist in the U. S. Department of Agriculture, died March 4 in New York City.

Rollin Chamberlin, 66, professor emeritus of geology at the University of Chicago and former editor of the *Journal of Geology*, died March 6 following a heart attack.

A Radio and Electrical Engineering Division, staffed by 231 persons, has recently been established by the National Research Council of Canada. B. G. Ballard, who has been in charge of the electrical engineering laboratory since his appointment to the staff in 1930, heads the new Division, creation of which was made necessary by the great expansion of research activities in electronics and electrical engineering. The announcement indicates that the Division represents a consolidation of work formerly carried on in the Division of Physics and Electrical Engineering. Mr. Ballard, a past chairman of the Ottawa Section, American Institute of Electrical Engineers, received the Order of the British Empire in 1946 for his contributions to the development of mine sweepers for enemy magnetic mines and the protection of ships against such mines.

The Hayden Planetarium will feature during March a new show entitled "Radar, Meteors, and Comets." Visitors to the planetarium will be able to see Comet 1947N, which appeared below the equator last winter, as well as the daily progress of the Bester Comet, which is at present heading northward and increasing in brightness. The history of Halley's Comet will also be reviewed, since the earth will probably coincide with its orbit next May 4 and October 20. Included in the show will be a demonstration of the association between meteors and comets and the technique of charting meteors by radar.

One of the largest existing collections of prehistoric animal skeletons has been donated by the University of Chicago to the Chicago Natural History Museum. The collection is said to contain about 8,000 fossil specimens collected over the past 50 years and valued in excess of $100,000. It is primarily representative of North American late Pennsylvanian and Permian amphibians and reptiles and South African Permian and Triassic faunas. The Museum's own large paleontological collection embraces the Cenozoic and later Mesozoic. When combined, therefore, the two collections will provide a rounded-out collection which will rank among the best in the world.

The Air University School of Aviation Medicine, Randolph Field, Texas, has been allotted one of the limited number of special research positions recently authorized by Congress to attract outstanding scientists to service laboratories. This is the first of a series of actions by the Air Force designed to create an Air Force Aeromedical Center. It is the intention of the School of Aviation Medicine to utilize the new allocation, which carries with it a salary of $10,000–$15,000 per annum, to establish a civilian position-vacancy for a director of research. Inquiries concerning this vacancy should be addressed to the Commandant.

Copies of 98 declassified British atomic energy papers are now available in microfilm or photostat form, according to an announcement from John C. Green, director, Office of Technical Services, Department of Commerce. Abstracts of the papers have been published in the February 6, 1948, issue of the *Bibliography of Scientific and Industrial Reports* (Vol. 8, No. 6). The price, order number, author, and title of each report is included in the abstract. It is expected that 25 additional papers will be available in the near future, and abstracts of these will be published in the *Bibliography* as received. Copies of the February 6 issue may be obtained from the Government Printing Office, Washington 25, D. C., for $.25. Subscriptions to the *Bibliography* at $10.00 per year may be placed with the Superintendent of Documents, Washington 25, D. C. Orders for the documents should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D. C., and should be accompanied by check or money order payable to the Treasurer of the United States.

Make Plans for—

Institute of Radio Engineers, March 22–25, 1 East 79th Street, New York City.

Midwest Power Conference, 10th annual, April 7–9, sponsored by Illinois Institute of Technology, Sherman Hotel, Chicago, Illinois.

Institute of Mathematical Statistics, April 14–15, New York City.

Electrochemical Society, spring meeting, April 14–17, Deshler-Wallick Hotel, Columbus, Ohio.

American College of Physicians, 29th annual session, April 19–23, San Francisco, California.

Society for the Advancement of Education, Inc., April 24, 15 Amsterdam Avenue, New York City.

American Institute of Chemists, annual meeting, May 7 (changed from May 8), New York City.

Fourth International Congresses on Tropical Medicine and Malaria, May 10–18, Washington, D. C.

Third Interamerican Cardiological Congress, June 13–17, Michael Reese Hospital, Chicago, Illinois.

First International Poliomyelitis Conference, July 12–17, Waldorf-Astoria Hotel, New York City.

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AAAS
Centennial Celebration
Washington, D. C.
September 13–17, 1948

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Comments and Communications

A Museum of the Social Sciences

A new type of museum is proposed herewith—a museum of the social sciences. Such a museum is feasible and could be a dynamic and pervasive educational force. Its substance would be the accumulated knowledge concerning man: his cultures; his behavior, as an individual and in groups; the wherewithal of his survival; his migrations; etc. To depict the life story of each people or group separately would be impractical and unnecessary. Essentially the same end could be achieved by considering large subject themes. For example, a Hall of Food would show the various foods and food habits brought over by all the immigrant groups, the diverse methods of preparation of foods by each, the continuous borrowing and exchange of foods and customs in the course of time, etc. Halls of the Family, Education, Government, Art, Hygiene and Medicine, Marriage, and so on could be taken up in turn, providing a panorama of historical development and present usage, each theme taking full cognizance of the extensive exchange, adaptations, and fundamental similarities among all peoples.

The term "Hall" is used figuratively: one large room or auditorium could comprise all the "Halls." Visitors would be seated comfortably; the "exhibits" could be seen on a screen in motion pictures, in intelligent sequence and with interesting and meaningful explanations heard from transcribed records. Motion pictures are suggested, perhaps in serial form, because they are a most effective educational medium and would make possible distribution of the museum to every city and hamlet in the country.

It may be noted in this connection that the museums in America are primarily a big-city luxury. Only 4.7% of all cities in the United States have a museum, open to the public, which even to some small extent depicts the natural history of man; 1.8% of towns under 25,000, 14.7% of communities of 25,000–100,000, and 65.2% of cities of 100,000 population or over have one or more such museums. At least 5 states apparently do not have a single community with a museum of natural history. (The computations are based on data given in *The museums in America,* by L. V. Coleman, Smithsonian Institution, Washington, D. C., 1939; the population figures refer to the 1940 census.) Indeed, the few great museums in the country could get together, pool their resources—financial, exhibits, scholarship—and produce authoritative, interesting, and meaningful films, thereby making available to every community in the country one of the finest museums in the world.

But, most of all, there is needed a vital, factual, persuasive museum of the social sciences that would reach all sections and levels of the population. Making such a museum available to communities over the country through the medium of films, even at a nominal cost, might well make it a self-sustaining project financially. Most important, it would put the social sciences to effective use, and contribute enormously to intelligent and sympathetic understanding of and among our peoples.

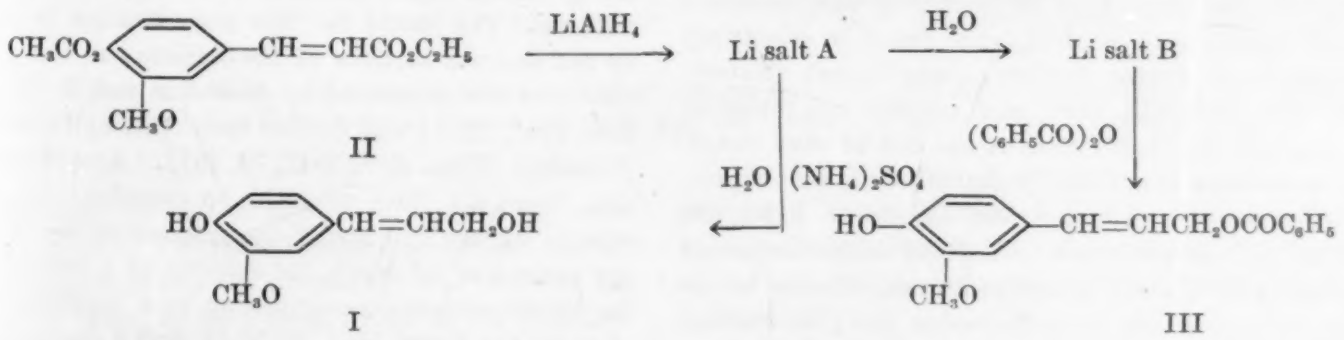
Statements made in this item are those of the writer and do not necessarily reflect the views of the U. S. Public Health Service.

MARCUS S. GOLDSTEIN
U. S. Public Health Service, Washington, D. C.

A Synthesis of Coniferyl Alcohol[1]

Coniferyl alcohol, I, which occurs in natural products as a glucoside (Tiemann and Haarmann. *Ber.*, 1871, 7, 608; Kubel. *J. prakt. Chem.*, 1866, 97, 243), and possibly as a benzoate (*Perf. Ess. Oil Rec.*, 1943, 34, 341), is not a readily accessible substance. It is usually isolated from the glucoside by an emulsin fermentation (*Ber.*, 1871, 7, 608)—a procedure that is inconvenient even when the natural isolate is available.

Its synthesis has now been achieved from relatively inexpensive starting materials. The action of lithium aluminum hydride on ethyl acetoferulate, II, with subsequent hydrolysis of the lithium-containing intermediate in the presence of ammonium sulfate gives a good yield of coniferyl alcohol. In the absence of ammonium salt, hydrolysis is incomplete, a second lithium salt being obtained; when this new substance is heated with benzoic anhydride, it gives coniferyl benzoate, III.



The synthetic coniferyl alcohol has all the properties recorded by Tiemann for his substance, isolated from natural sources.

The complete experimental details will be published shortly elsewhere.

C. F. H. ALLEN and JOHN R. BYERS, JR.
Eastman Kodak Company, Rochester, New York

[1] Communication No. 1173, Kodak Research Laboratories.

Production of Mesons by the 184-Inch Berkeley Cyclotron

We have observed tracks which we believe to be due to mesons in photographic plates placed near a target bombarded by 380-Mev alpha particles. The identification of the particles responsible for these tracks was first made on the basis of the appearance of the tracks.

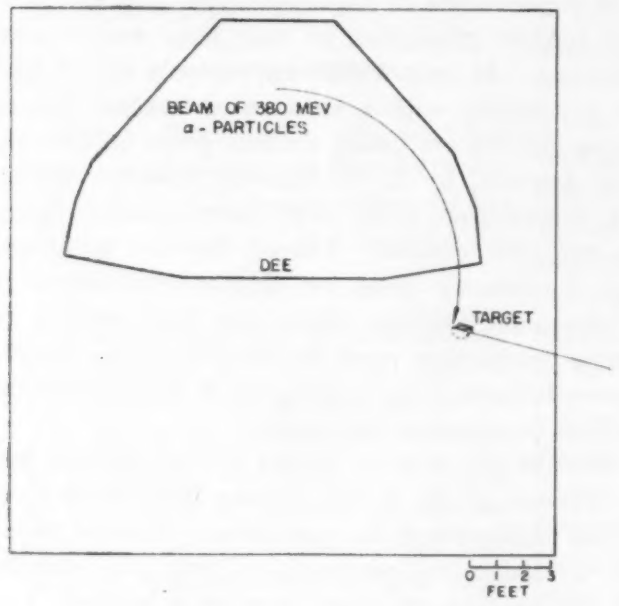


FIG. 1. Arrangement of apparatus in the cyclotron. *Top*: Plan view of cyclotron showing position of target. *Bottom*: Detail view of target showing meson trajectory and position of stack of photographic plates.

These show the same type of scattering and variation of grain density with residual range found in cosmic-ray meson tracks by Lattes, Occhialini, and Powell (*Nature, Lond.*, 1947, 160, 453, 486), and roughly two-thirds of them produce observable stars at the end of their range. Their appearance is sufficiently characteristic that a practiced observer can recognize them on sight. Later, the identification was confirmed by a direct determination of the mass from $H\rho$ and range measurements (to be described below) which gave the value 313 ± 16 electron masses, showing that they are almost certainly the heavy mesons described by Lattes, Occhialini, and Powell.

The experimental arrangement is shown in Fig. 1. The circulating beam of 380-Mev alpha particles inside the cyclotron passes through a thin target, producing mesons and other particles; the negative mesons are sorted out by the magnetic field and roughly focused on the edge of a stack of photographic plates placed as shown. All the measurements reported here refer to negative mesons produced in a carbon target by full-energy alpha particles, although a few observations have been made with other targets and energies. Beryllium, copper, and uranium targets were bombarded with full-energy alpha particles and gave mesons in numbers comparable to those from carbon; a carbon target bombarded with 300-Mev alpha particles gave a greatly reduced yield.

The photographic plates used are Ilford Nuclear Research plates, type C.2, with an emulsion thickness of $50\,\mu$; the exposure times were about 10 min, and the alpha-particle current about $\frac{1}{10}$ microampere. Each plate shows about 50 meson tracks along its edge, with about 10 times as many heavy-particle tracks in the same area. The latter are attributed to stars and recoils produced by neutrons and are found all over the plates. Fig. 2 shows a typical meson track which produces a star; Fig. 3, one which does not.

The opportunity for making a mass determination is furnished by the magnetic deflection of the mesons. By measuring the point and angle of incidence of each track on the edge of the plate, the radius of curvature in the field is determined. The range in the emulsion is measured with an eyepiece micrometer, and to this is added the path through a one-mil aluminum foil covering the plates. (The earlier observations were made with black paper covering the plates, but these are not suitable for range measurements because of the uncertain thickness of the paper.) A total of 49 tracks have so far been measured in this way, with the following results. There is no significant difference between the masses of the star and no-star particles, and the mean mass of all the particles is 313 ± 16 electron masses; the spread in individual values is probably within the errors of the measurements. The most important source of error is the scattering of the particles in the aluminum foil and in the first $80\,\mu$ of the emulsion. The angle measurements could not be made closer to the edge than this because of the distortion of the emulsion on processing.

The mass value found would indicate that at least 160 Mev should be available in the collision to produce these particles, and furthermore it seems likely that this energy should be concentrated in a single nucleon-nucleon collision. The means for this concentration is provided by the internal motions of the nucleons in the colliding nuclei, as first suggested by McMillan and Teller (*Phys. Rev.*, 1947, 72, 1) and further developed by Horning and Weinstein (*Phys. Rev.*, 1947, 72, 251) According to this idea, there are three velocities to consider: the relative velocity of the two nuclei (corresponding to an energy per nucleon of 95 Mev), the velocity of a nucleon inside the alpha particle (corresponding to a maximum energy of about the Fermi limit, 25 Mev), and a similar internal velocity in the carbon nucleus. In the most favorable collision these can add together, giving an effective available energy of $1/2(\sqrt{95} + \sqrt{25} + \sqrt{25})^2 = 195$ Mev in the center of mass system of the two nucleons concerned. Thus, the observations are not inconsistent with a simple picture of meson formation by nucleon-nucleon collisions.

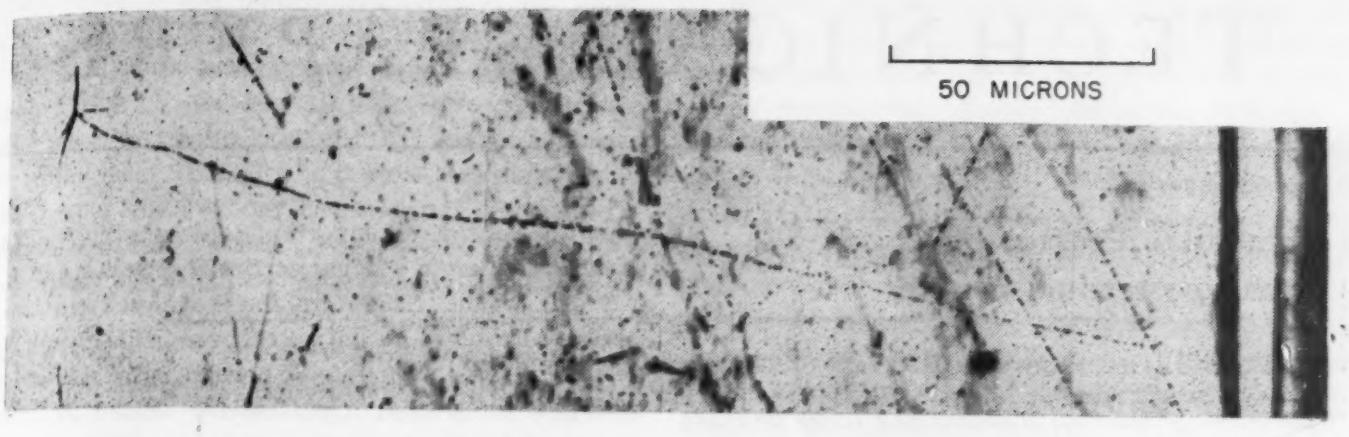


FIG. 2. Track of meson which initiates a star. Meson enters the edge of the photographic plate on the right, moves toward the left, and forms star in upper left hand corner. Note the scattering in the track and the increase in grain density toward the star. (The heavy parallel lines on the right show the edge of the photographic plate.)

The measurements reported here are admittedly preliminary, and much more work is to be done, but it seems certain that this marks the beginning of meson study under controllable laboratory conditions. The large intensities, approximately 10^8 times those available in cosmic rays, mean that the rate of progress in this field can be greatly accelerated.

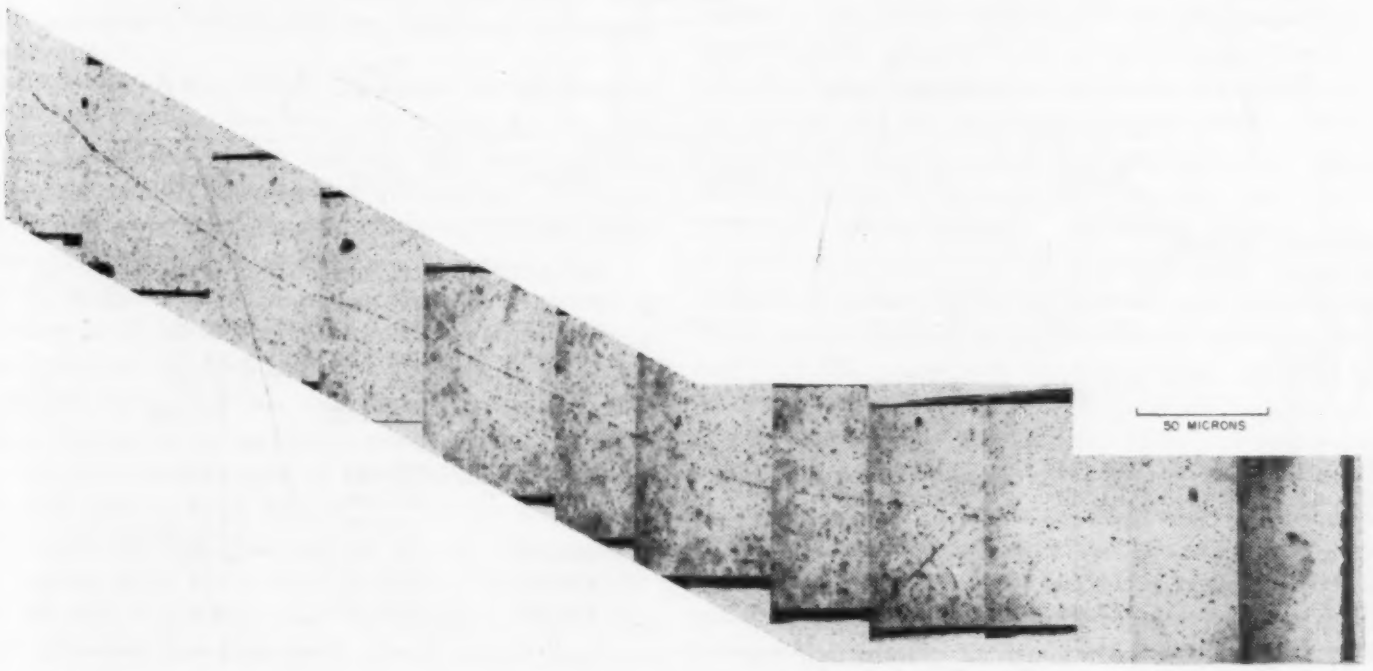


FIG. 3. Track of a meson which does not initiate a star. Meson enters the edge of the photographic plate on the right and moves toward the left. Note the scattering in the track and the increase in grain density toward the left.

In conclusion, we wish to express our deepest appreciation to Prof. E. O. Lawrence, whose interest and encouragement have made this work possible. The program has been greatly aided by help from Profs. R. L. Thornton, E. M. McMillan, R. Serber, and L. W. Alvarez. The authors are indebted to John Burfening, Lt. Col., U. S. Army, for his work on methods of exposing plates in the cyclotron. We also wish to thank Mr. D. J. O'Connell and Mr. A. J. Oliver for microscope work and photography, and Mr. Duane Sewell and the cyclotron crew for making the bombardments. The construction of the 184-inch cyclotron was made possible by a grant from the Rockefeller Foundation. This paper is based on work performed under Contract No. W-7405-eng-48 with the Atomic Energy Commission, in connection with the Radiation Laboratory, University of California, Berkeley, California.

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TECHNICAL PAPERS

The Immediate Pressor Effect of Desoxycorticosterone Acetate[1]

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The relation of the adrenal cortex to arterial hypertension is a controversial one. In cases resembling Cushing's syndrome, however, the evidence that adrenal cortical hyperfunction is concerned in the production of arterial hypertension is suggestive. The administration of desoxycorticosterone acetate and sodium chloride has been reported to produce renal vascular lesions in rats (*4*) and to elevate the blood pressure of patients with arterial hypertension (*1*) and with Addison's disease (*3*). The blood pressures of normal individuals, when given similar quantities of desoxycorticosterone acetate and salt, also became elevated, but only after a long period of time (*2*). A factor in the adrenal cortex which contributes to vascular constriction has been postulated (*5*).

It was considered important to determine whether substances similar to adrenal cortical hormones had a direct vascular action. Therefore, 5 mg of desoxycorticosterone acetate, dissolved in 2.5 cc of propylene glycol, was injected intravenously into 5 normal subjects and 5 suffering from arterial hypertension. Blood pressure was measured by direct puncture of the brachial artery, using a Hamilton optical manometer. Blood content of the ear was measured by a photoelectric plethesmograph, and venous pressure by an optical membrane manometer. Changes were recorded on a photokymograph.

The injection of propylene glycol alone (2.5 cc) did not affect the blood pressure except in one instance, where its administration was accompanied by pain. The injection of DCA in the same quantity of propylene glycol was followed shortly by a significant rise in arterial pressure (Table 1) in the hypertensive individuals. The effect on the blood pressure of normal subjects was slight or absent.

TABLE 1

CHANGES IN BLOOD PRESSURE AFTER THE INTRAVENOUS INJECTION OF 5 MG OF DESOXYCORTICOSTERONE ACETATE (mm Hg)

	2.5 cc Propylene glycol			5 mg DCA			Min after DCA for maximum blood pressure change
	Before	After	Change	Before	After	Change	
Hypertensive subjects							
T.A. (m)				197/157	217/175	+20/18	10
F.W. (f)	208/131	213/134	+5/3	213/134	217/150	+4/16	16
L.C. (f)	237/110	232/127	−5/+17*	232/127	280/160	+48/33	10
M.L. (f)				207/88	225/112	+18/24	5
F.H. (f)	203/115	209/122	+6/7	209/122	217/145	+8/23	30
				191/105	203/115	+12/10†	10
Normal subjects							
C.C.‡ (f)	154/74	172/66	+18/−8	196/65	179/63	−17/−2	9
J.M. (m)	101/63	102/62	+1/−1	102/62	107/66	+5/4	14
					115/75	+13/13	32
L.H. (f)				120/60	132/61	+12/1	27
V.E. (f)	114/56	119/60	+5/4	119/60	120/64	+1/4	34
W.G. (m)	122/64	130/66	+8/2	136/66	133/66	+3/0	15

* Moderate pain in arm resulting from injection.
† After 5 mg of progesterone intravenously.
‡ Patient exhibited wide pulse pressure of undetermined cause.
Note: Blood pressure values are average of representative readings during ½–1 min. (m) = male (f) = female.

No significant changes were observed in venous pressure or in the volume of blood in the ear. Changes in cardiac output were estimated by the ballistocardiograph in four instances, and no significant differences were observed after injection of DCA. In two instances, lead 2 of the electrocardiogram was not altered.

In one case, 5 mg of progesterone, dissolved in 2.5 cc of propylene glycol, was administered intravenously and

[1] Supported by a grant-in-aid from the U. S. Public Health Service. The desoxycorticosterone acetate was generously furnished by the Schering Corporation, Bloomfield, New Jersey.

[2] U. S. Public Health Service Research Fellow.

was followed by a less marked elevation of the blood pressure (Table 1).

The responses obtained were prolonged, lasting for the duration of the experiment—at least 30 min. In one instance, blood pressure measured by the auscultatory method 1½ hrs later, showed that the rise was maintained.

From these results it can be concluded that desoxycorticosterone acetate, where administered intravenously, acts as a pressor substance in hypertensive individuals.

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The Nasal Cavity of the Rat in Pharmacological and Other Experimentation

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Investigation of the effects of drugs on the mucous membrane of the nose has been encouraged by the fact that in various laboratory animals the nasal mucous membrane is easily accessible for such study. Furthermore, the effects of drugs can be observed without interference with the function of other vital organs.

The basis for this type of experiment is complete orientation as to (1) the normal anatomy and histology of the animal in question and (2) knowledge of pathologic conditions as they are encountered spontaneously, *i.e.* in the course of normal life under laboratory conditions or in the animal farms of the institutions, without exposure to experimental factors.

It has been felt that the progress of such experimental work requires more data concerning the normal conditions and the "spontaneous" pathologic phenomena. The present study has been made of the rat as one type of laboratory animal readily available and frequently used in experimentation with drugs. In order to obtain data from a cross section of the species, 40 young animals of both sexes and from different, but known, strains of various laboratories were used. Born in the respective laboratories, they had been employed solely for breeding purposes, and their diet had been a normal one, designed to maintain a high standard of general good health. After decapitation, a series of frontal sections were cut through the entire length of the nasal cavity.

Pathologic findings included: in the main cavity, hemorrhage (4 times), excessive mucus (3), excessive fibrin (25), suppuration (22); in the maxillary sinuses, hemorrhage (1), excessive fibrin (6), suppuration (8). In two of the rats in which the main cavity was regarded as normal, pus was found in the maxillary sinuses. Fibrin was designated as excessive on the basis of amount and unusual intensity of round cell activity around and within the meshes. Among others, the following additional pathologic findings were noted: abundance of goblet cells in large areas, cystlike empyemas between roots of turbinals, granulatory masses on the septum, formation of osteophytes by calcification of suppurative masses, foreign bodies probably of plant origin, with collateral inflammatory reactions. In some instances the choanae were completely blocked. With allowance of a wide margin for normal limits, pathologic changes were found in 24 animals (60%) (*2*).

Some anatomical peculiarities were noted of which no reports could be discovered (*1*):

(1) Characteristic of the region of the choanae in the rat is a *window in the septum* of the lower (respiratory) portion of the nasal cavity, representing a confluence of the two inferior meatuses of the respiratory half, immediately behind the vomeronasal organ. This renders any plan, using one nasal airway for experiments while leaving the other intact for comparison, illusory.

(2) Covered by the bifurcating canopy of the terminal laminae which connect the septum of the ethmoid part to the lateral nasal walls, a tentlike antechamber is formed. The nasal opening of the pharyngeal duct is located under this roof. The duct extends forward the length of the ethmoid part between the lower edge of its septum and the secondary (hard) palate. This portion, which may be called the *subseptal duct,* forms a singular connecting tube between the nose and the pharynx. In the region of the septal window, anterior to the nasal orifice of the subseptal duct, a crossroad is formed between (a) the anterior and posterior part of the nasal cavity, (b) the right and left nasal airway, and (c) the nasal and the pharyngeal cavities. The crossway is situated in the very center of the nasal cavity at the boundary of the anterior (respiratory) and posterior (ethmoid) sections. This disposition effects peculiarities of clearance, since secretions must be conveyed from the anterior section posteriorly and from the posterior section anteriorly to reach any outlet. The inadequacy of clearance accounts for the frequency with which foreign bodies tarry in the cavities, with fully developed collateral reactions as evidence of their long stay. Of more consequence is the difficulty in elimination of pathologic secretions. On the other hand, the slowing down of ventilation may be useful from the point of view of the macrosmatic analysis of the gaseous and liquid contents of the nasal cavities.

(3) Massive *lymphoid accumulations* in the mucosa of the two opposite lateral nasal walls mark the region of the anterior orifice of the subseptal duct. Thick cushions of lymph follicles, showing the typical structure, inclusive reticulization of the epithelium, and transmigration of lymphatic elements to the free mucosal surface follow as a solid mass the foremost section of the canal. The presence of lymphoid masses around the anterior orifice—hitherto overlooked—is understood better if one consid-

ers the subseptal duct as a prolonged pharyngeal tube; one is then reminded of the lymphatic ring at the oral entrance of the pharynx. Here a kind of secondary Waldeyer ring is formed inside the nasal cavity.

Each of these animals was apparently in perfect health, yet anatomic peculiarities, together with frequency of nonexperimental pathologic changes, warrant utmost caution in evaluating findings that have been made by comparison with such "blank" or "control" animals.

An intact peripheral olfactory organ is necessary in experimental investigation of, among others, *psychologic phenomena*. In this field of research the rat has acquired an increasingly important role. Among the experiments in question are those dealing with olfactory discrimination in general, in which response with the help of olfactory cues is observed. The organ of smell is used in studying certain special drives or problem-solving behavior—for example, marking the true path of a maze with an olfactory trail. Results won in this way should not be declared valid until it is established by a postmortem histologic analysis that at the time of the experiment the organs in question were functionally normal.

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Sorption of Fumigant Vapors by Soil

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The use of toxic vapors to control such pests as the rat, soil nematode, boll weevil, and louse is well known. Fumigants are also of great value in the control of rodent pests such as the ground squirrel, pocket gopher, rat, prairie dog, and woodchuck, all of which live in underground burrow systems. Research by this laboratory in the control of burrowing rodents made a study of the persistence of toxic gases in the presence of soil highly desirable.

To our knowledge, only one similar experiment has been reported in the literature. Chisholm and Koblitsky (*2*) found that methyl bromide gas was sorbed by soil, the amount ranging from 0 to 41% in 6 hrs, depending on the type and the water content of the soil used. For example, in 1 hr moist clay sorbed approximately 10% of the methyl bromide originally present in the test chamber. This value increased to 17% after 6 hrs. Concentrations of hydrogen cyanide have been found to be reduced by cotton and jute (*6*), by orange fruit and leaves (*1*), and by wheat (*3*). The sorption of methyl bromide by wheat has also been studied (*7*). In addition, Lubatti and Harrison showed that wheat sorbed hydrogen cyanide, ethylene oxide, trichloroacetonitrile, and methyl bromide in a decreasing order of efficiency (*4*). Sorption and the moisture content of the wheat were directly proportional. Finally, the persistence of carbon monoxide in coal mines after explosions is well known.

In the experiments to be reported, known amounts of various toxic gases were introduced into a 628-liter, gas-tight chamber containing several cages freshly loaded with a sandy clay. The metal chamber had two large glass windows and an inner lining of paint which was chemically resistant. The soil had an average moisture content of approximately 11%, and the amount of surface exposed, calculated from the dimensions of the cages, was roughly 13 sq ft. During the first 5 min of each run, the gases were distributed uniformly throughout the chamber with a fan.

Successive samples of chamber air were collected at 10-min intervals for a 1-hr period and analyzed chemically for toxic content. Control experiments for each gas were also run. In these, exactly the same procedure as outlined above was used, except that no soil was placed in the cages which were in the chamber. An attempt was made to have an initial concentration of 5–10 mg of the agent/liter of chamber air in all of the experiments.

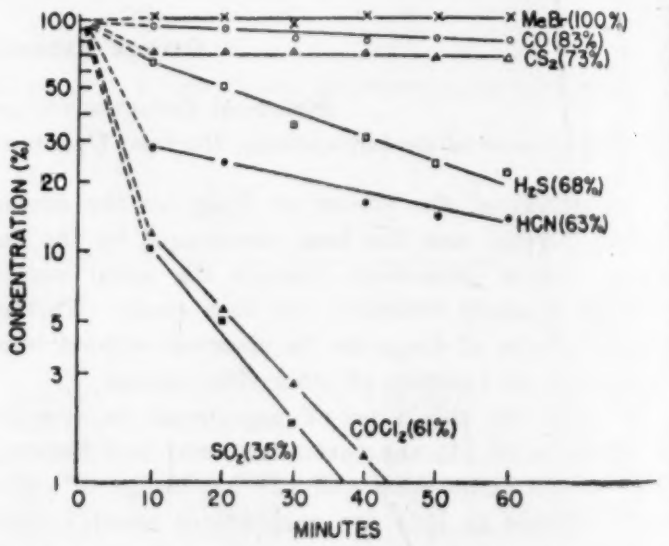

FIG. 1. Effect of soil on the persistence of fumigant vapors. Concentration is expressed as per cent of the original amount of gas calculated to be present in the chamber. The percentage after each of the curves represents the amount of gas present after 1 hr in the no-soil control experiments.

The changes in concentration of the various gases with time, shown in Fig. 1, are the average of four separate runs.

The values in parentheses were obtained in control experiments in which the chamber contained no soil. These represent the percentage of each gas, in terms of the original concentration, which was present in the chamber 1 hr after the gas had been introduced. The figures are the average of two runs for each gas.

Under the existing experimental conditions, soil had little effect on methyl bromide, carbon monoxide, and carbon disulfide. The final concentration of each of these gases was practically the same whether or not soil was used. The cause of the decrease in the amount of the relatively unreactive carbon monoxide and carbon disulfide in the absence of soil is not known.

The soil markedly sorbed the remaining four toxic gases studied. In fact, after 40 min, practically all of the sulfur dioxide and phosgene had disappeared. The fact that only 35% of the original sulfur dioxide was found after 1 hr in the no-soil tests underlines the sorbability of this chemical. Only 20% of the hydrogen sulfide and 14% of the hydrogen cyanide remained after 1 hr.

Since these data demonstrate the importance of the sorbability of a gas, an examination of the presently-used rodenticide fumigants in the light of these results may prove to be useful. One burrowing rodent, the woodchuck, is best controlled with fumigants (*5*, *8*). Calcium cyanide is used quite successfully, as is carbon disulfide and also a Fish and Wildlife Service cartridge which liberates carbon monoxide upon burning. The present experiments suggest strongly that, inherent toxicity aside, the effectiveness of the latter two rodenticides is due to a considerable degree to their low sorbability by soil. On the other hand, calcium cyanide is often satisfactory because a large excess is used in practice. In this way, sufficient hydrogen cyanide is generated in the burrow over a period of time long enough to kill the animal.

The factor of sorbability should, in fact, be kept in mind whenever it is necessary to maintain a concentration of vapor in a confined space. This is true, for example, in the fumigation of wheat, cotton, fruit, etc. for the removal of injurious insects.

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Staining of the Stem Tissue of Plants by Triphenyltetrazolium Chloride

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In the course of developing a process for the manufacture of 2,3,5-triphenyltetrazolium chloride (*1*, *4*, *5*, *6*), it has been found that portions of the cross-section of twigs from certain trees, particularly the willows, are stained by the reagent. This was not entirely unexpected in view of the findings of Kuhn and Jerchel (*2*), Lakon (*3*), Porter, Durrell, and Romm (*7*), and Mattson, Jensen, and Dutcher (*5*) on the staining of yeasts and of the seeds and fruit of various plants by tetrazolium salts.

Tips of twigs, cut in December from living trees and shrubs, were immersed in a 1% aqueous solution of 2,3,5-triphenyltetrazolium chloride. Sections from the same twig were heated in a test tube suspended in a boiling water bath for 15 min.

All of the unheated sections tested, with the exception of those of sumac and mock orange, developed a distinguishable red coloration in the cambium layer. The sumac was initially so highly pigmented that it is doubtful that any staining could be distinguished if it occurred. The mock orange showed a rusty red circle around the pith which may have been caused by the reagent or by normal enzymatic browning. The heated sections of all varieties tested exhibited neither browning nor reddening.

Most of the sections (maple, apple, plum, hawthorn, pine, spruce, cedar, etc.) required about 4 hrs for the development of the red color. The band of color usually appeared first in the cambium, but, in the maple and apple, a distinct colored band was observed around the pith as well. Considerable browning preceded the staining in most of the deciduous species. Pine, spruce, and cedar were stained irregularly over the cross-section.

In contrast to the varieties discussed above, sections of willow were stained in the cambium within 1–2 min, followed by slow development of color throughout the phloem. No color appeared in the xylem or pith. This remarkably rapid reaction of the willows suggested that there might be a fundamental difference between the cambium of the willows and that of the other shrubs. Because of the well-known ease with which willow cuttings are able to root, it was thought that the rapid reaction might be connected with this characteristic. Since, however, a rose cutting required nearly 24 hrs for the reddening of the cambium, the significance of the extremely rapid reaction of willows is still obscure.

Inasmuch as these experiments have shown that sections of a number of living trees and shrubs are stained by immersion for 4–24 hrs in a 1% aqueous solution of 2,3,5-triphenyltetrazolium chloride, that sections of twigs which have been heated are not stained, and that sections of willow are stained with exceptional rapidity, it is considered that this new application of triphenyltetrazolium chloride will be of value in determining the viability of trees, shrubs, and cuttings.

Since this laboratory is equipped and staffed primarily for chemical research, the above findings are presented in the hope that biological laboratories may find them of sufficient interest to subject the problem to systematic study.

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Development of a Strain of Houseflies Resistant to DDT[1]

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Since DDT is being widely used on a great variety of insect pests, and since it is much superior to the older insecticides for the control of houseflies, tests were made at the Orlando, Florida, laboratory of the Bureau of Entomology and Plant Quarantine to determine whether the extensive use of this chemical on several generations of houseflies would eventually produce flies that were resistant or tolerant to DDT. The results of these tests are reported in this paper.

TABLE 1

PER CENT MORTALITY IN 24 HRS OF THE 14TH GENERATION OF SPECIAL AND REGULAR-STOCK HOUSEFLIES EXPOSED TO A DDT FINE-MIST SPRAY

Test No.	4-Day-old flies		5-Day-old flies	
	Regular stock	Special stock	Regular stock	Special stock
1	69	38	75	52
2	77	22	78	41
3	65	41	76	35
4	87	19	51	42
5	49	17	67	52
6	66	37	70	35
7	78	41	68	30
8	55	19	70	26
Average	68	29	69	39

Quayle (*4*) reported on the resistance of California red scale (*Aonidiella aurantii* (Mask.)) in California to fumigation with hydrocyanic acid gas. Hough (*1*) discovered that some strains of codling moth (*Carpocapsa pomonella* (L.)) were resistant to arsenicals and other insecticides. Knipling (*2*) found that larvae of the primary screw-worm (*Cochliomyia*) *Callitroga americana* (C. & P.)) developed a high degree of resistance to phenothiazine when reared repeatedly on media containing this chemical. Smith (*5*) discussed at length the problems of acquired resistance and racial segregation in insect populations.

In the tests at Orlando approximately 300 houseflies from the regular laboratory colony were exposed to a DDT fine-mist spray in a 100-cu ft chamber described by Lindquist and Madden (*3*). One ml of a 1% DDT-kerosene spray was discharged into this chamber, and the flies were exposed for 2 min, the initial exposure being made on January 30, 1946. About 10% of the flies survived, and these were used as the parent stock in establishing a new special colony. Each of 14 generations of flies was similarly exposed to DDT, and the survivors were placed in clean cages and allowed to propagate. The special flies were reared under the same conditions and provided the same type of food as the regular colony.

After the third generation, 4-day-old flies from the regular colony and from the special stock were exposed to the mist spray at the same time. In this test, as well as in comparative tests with succeeding generations, the survival of the special flies was greater than that of the flies from the regular stock. However, the percentage varied somewhat from generation to generation. An increased quantity of DDT was required to kill 90–95% of the special flies.

The results of a series of tests with the 14th generation are shown in Table 1. The average mortality in 16 paired tests with approximately 1,600 4- and 5-day-old flies was 69% for the regular stock and 34% for the special flies. These data show that selective breeding produced a strain of flies that was more resistant to DDT spray than were flies from the regular stock.

[1] This work was conducted under a transfer of funds from the Office of the Surgeon General, U. S. Army, to the Bureau of Entomology and Plant Quarantine.

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Susceptibility of DDT-resistant Houseflies to Other Insecticidal Sprays[1]

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Lindquist and Wilson (*3*) have described the development of a special strain of houseflies (*Musca domestica* L.) that was comparatively resistant to DDT space sprays. This strain was developed by rearing for a number of generations the progeny of individuals that recovered from the effects of DDT sprays. Since Quayle (*4*) observed that red scales which had developed resistance to hydrocyanic acid were difficult to kill with methyl bromide, ethylene oxide, and oil, and Hough (*1*), during the course of his work with arsenical-resistant codling moths, found that these strains were less susceptible to other insecticides also, the question arose as to the susceptibility of the new strain of houseflies to insecticidal sprays other than DDT.

To determine whether the resistance observed by Lindquist and Wilson was specific for DDT, a large series of paired tests was conducted in which 5 insecticides, in addition to DDT, were tested as space sprays against the 15th, 16th, and 17th generations of this special stock of flies in comparison with flies from the regular colony. Both strains had been reared by the same technique. The 5 insecticides used were technical chlordane, rote-

[1] This work was conducted under a transfer of funds from the Office of the Surgeon General, Department of the Army, to the Bureau of Entomology and Plant Quarantine.

none, chlorinated camphene, pyrethrum extract (containing 20% of pyrethrins) mixed with piperonyl cyclonene, and Thanite (a mixture of fenchyl and bornyl thiocyanoacetate). In another series of tests the two stocks of flies were compared for their susceptibility to residual deposits of DDT.

The space-spray tests were conducted in 100-cu ft cabinets by the technique described by Lindquist and Madden (*2*). For each test, 1 ml of solution in cyclohexanone was atomized into a cabinet and permitted to settle for 20 sec. Two small screen cages containing 4-day-old flies, the special stock in one and the regular stock in the other, were then introduced into the cabinets in juxtaposition and swung back and forth for 2 min. Immediately afterward, the flies were transferred to clean holding cages, furnished honey and water, and held at a temperature of 80° F until mortality counts were made. To increase the number of tests that could be made in a single day, two cabinets were used alternately. While exposures were being made in one, the other was aired. Each concentration was tested twice on the same day, a test being made in each of the two cabinets. Replications were run on 5 different days. Since approximately 50 flies of both sexes were used in each cage, the averages for each concentration given in Table 1 are based on about 500 flies from 5 lots of each kind of stock. Mortality in untreated control cages did not exceed 1.5%.

TABLE 1

TOXICITY TO REGULAR AND SPECIAL STOCKS OF HOUSEFLIES OF DIFFERENT CONCENTRATIONS OF 6 INSECTICIDAL SPACE SPRAYS

Material	Concentration (%)	Mortality (%) in 48 hrs*	
		Regular stock	Special stock
DDT	5.0	100	99
	2.0	99	91
	1.0	91	67
	0.5	69	37
	0.25	43	5
Chlordane	2.0	100	99
	1.0	100	98
	0.5	96	76
	0.25	81	56
Pyrethrins plus 5% of piperonyl cyclonene	1.0	93	86
	0.5	94	82
	0.25	78	30
	0.1	41	19
Chlorinated camphene	5.0	85	79
	2.0	93	58
	1.0	64	20
	0.5	54	18
Rotenone	12.0	69	56
	5.0	50	40
	2.5	44	18
	1.0	29	8
Thanite	50.0	99	97
	25.0	96	87
	10.0	61	32
	5.0	14	2

* The 24-hr count is shown for DDT, as there is usually little increase in mortality after that length of time with this material.

The special stock was distinctly more resistant to all the materials than the regular colony. Although a few reversals occurred in the individual tests, none appeared in the final averages at any concentration. To obtain equal mortalities, approximately twice as much toxicant was required for the special stock as for the regular stock with DDT, chlordane, pyrethrum, and rotenone. An even higher proportion of chlorinated camphene was needed, but with Thanite somewhat less than twice the amount was required for the special stock.

In the tests of residual DDT treatments, the inside surfaces of 4 small plywood boxes were sprayed with an acetone solution in amounts sufficient to give a dosage of 6 mg of DDT/sq ft. An average of about 65 flies/test were confined in each of the boxes, and the regular and special stocks were introduced alternately. The exposure periods were 30, 60, and 120 min, after which the insects were transferred to clean holding cages and held at 80° F. One series of tests was run with flies from the 21st generation of the special stock, and another with the 22nd generation. The 24-hr mortality records are summarized in Table 2. Each figure represents an average of the two replications for each exposure period and is based on totals of more than 250 flies.

TABLE 2

PER CENT MORTALITY OF MALES AND FEMALES FROM THE REGULAR AND SPECIAL STOCKS OF HOUSEFLIES EXPOSED TO RESIDUAL DEPOSITS OF DDT

Exposure (min)	Males		Females	
	Regular stock	Special stock	Regular stock	Special stock
30	62	14	9	2
60	92	66	63	16
120	95	77	84	46

Each sex of the special stock of flies was definitely more resistant to DDT residues than the corresponding sex of the regular flies, and the increased resistance appeared to be approximately equal to that shown in the space-spray tests. Twice as long an exposure, or even more, was required to cause mortalities among the special stock equal to those of the regular stock.

These tests show that the method of selection resulted in the development of an unusually strong stock of flies rather than one having a specific resistance to DDT. This stock also showed an increased resistance to the effect of residual deposits of DDT. In view of the increasing use of DDT sprays for housefly and mosquito control, it seems possible that, in time, a similar increase in resistance may occur under natural conditions.

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IN THE LABORATORY

A Simplified Diffusion-Dehydration Technique in the Microtomy of Tissues[1]

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The procedure described below for the preparation of bundles of root tips for transverse sectioning with the microtome involves a departure from the conventional method of dehydration which can be applied to the preparation of other objects of similar size at a considerable economy of time and materials. The dehydration process from water to 80% alcohol is accomplished in a single step which involves a continuous diffusion of molecules without the production of violent convection currents.

The fixed tissues, after being washed, are placed in 1 ml of 15% alcohol, to which is immediately added 4 ml of 97.5% alcohol in such a way as to prevent the sudden mixing of the two concentrations. A paper disc prevents such mixing and makes it possible to establish an interface between the two concentrations. This interface can be maintained for a period longer than 24 hrs at ordinary room temperatures, but at a temperature of approximately 40° C it will gradually lose its identity as the diffusion gradients are resolved and equilibria are established between the alcoholic and aqueous constituents. The resultant concentration, about 80%, is attained by a gradual and continuous diffusion process which causes no perceptible injury to the tissues. It is generally considered safe to leave tissues in this concentration until it is convenient to process them further.

The method is especially valuable for class laboratory routines. There is no need for concern over the possibility of allowing the tissues to remain too long in the lower concentrations of alcohol, since the diffusion process makes the approach to 80% alcoholic concentration automatic and obviates the necessity for students to enter the laboratory outside scheduled class hours in order to change solutions. The full possibilities of the method have not yet been investigated. It may be possible to process larger pieces of tissue than the example described, using the same method but increasing the sizes and amounts of the materials proportionately. The details of the method of dehydration are embodied in the description given for the handling of root tips in bundles with the object of concentrating large amounts of meristematically active tissues on a single slide.

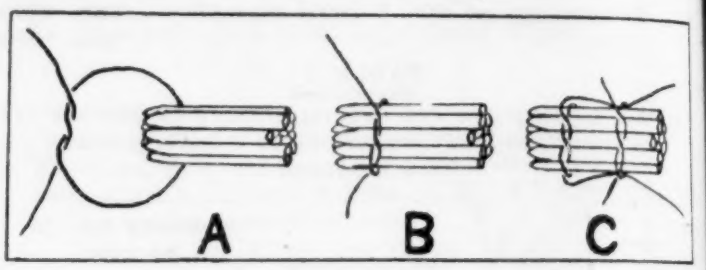
The materials used include: root tips (grown either in water or in a moisture saturated atmosphere); Craf or Navaschin type fixative (*1*); glass slide and No. 50 cotton thread; shell vials, 15 mm in diameter; paper discs, 17 mm in diameter (cut with No. 9 cork borer); 15% alcohol (10% ethyl + 5% normal butyl + 85% water); 97.5% alcohol (equal proportions of 95% ethyl and absolute normal butyl mixed); and 100% alcohol (25% absolute ethyl + 75% absolute normal butyl).

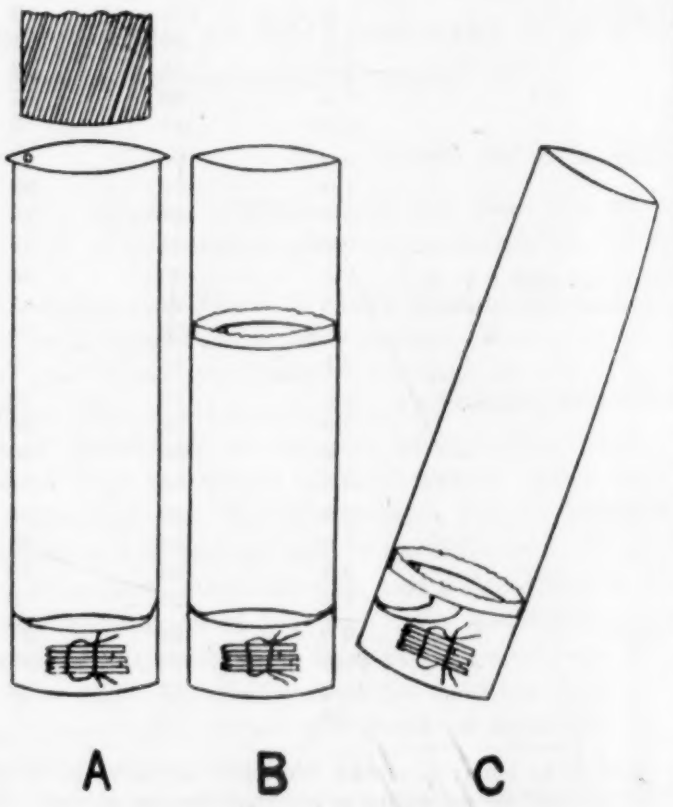
[1] Journal Paper No. 325, Purdue University.

[2] Now at the Florida Agricultural Experiment Station, Gainesville.

METHOD

(1) Root tips about 10 mm long are fixed for 24 hrs or longer in a Craf or Navaschin type fixative and rinsed briefly in water.





FIGS. 1 (above) and 2 (below).

(2) Five to 10 medium-diameter root tips are placed parallel to each other with their meristematic ends all pointing the same way and flush with each other over one side of an open loop of No. 50 thread, which is spread out on a wet glass slide (Fig. 1 A). The surface film causes the wet root tips already placed to cohere slightly so that they tend to remain undisturbed while others are being added to the bundle.

(3) The loop is drawn snugly about the bundle (Fig. 1 B). If the thread is drawn too tightly, the meristems will flare apart. The free ends of this loop are prevented from projecting forward and interfering with subsequent sectioning by being tied back with a second loop placed proximal to the first (Fig. 1 C).

(4) As many as three such bundles are placed in a vial and covered with 1 ml of 15% alcohol.

(5) A hole about 1 mm in diameter is punctured with a dissecting needle in a paper disc about 3 mm from the margin.

(6) The disc is centered, with the rough edges of the hole turned up, over the top of the vial so that the edges of the paper will project uniformly about 1 mm beyond the circumference of the vial (Fig. 2 A).

(7) With a cylindrical plunger (e.g. a No. 6 or No. 5 cork borer) which just fits easily into the vial, the disc, the edges of which are turned up in the process, is forced part way down into the vial (Fig. 2 A and B).

(8) The vial is then tilted (Fig. 2 C) so that the hole in the disc is uppermost as the disc is pushed the rest of the way downward into contact with the liquid. Air displacement through the hole is usually complete if this step is adroitly executed, but small bubbles are not objectionable. Highly absorbent papers are not recommended for the discs, because they are less likely to maintain their shape when wet and their absorbency makes complete air displacement more difficult.

(9) Four ml of 97.5% alcohol is added above the disc. No special care is necessary, since the paper quite effectively prevents the two concentrations from mixing immediately. For demonstration purposes, one edge of the disc may be drawn up very slowly with a curved pair of forceps or a hooked needle and may thus be removed completely, revealing the interface between the two concentrations. In practice it is not necessary to remove the disc, because its freely permeable nature does not interfere appreciably with the diffusion process.

(10) The vial is then stoppered and held at approximately 40° C for a minimum of 24 hrs. A bacteriological incubator set at 37.5° C is satisfactory, but a period of somewhat longer than 24 hrs may be necessary before a complete breakdown of the interface is accomplished and a uniform mixture of the two concentrations is established. It has not yet been determined whether higher temperatures for shorter periods would be equally effective without injury to the tissues.

(11) The tissues may now be left indefinitely in the resultant 80% alcoholic concentration, or the portion above the disc may be replaced with 4 ml of 100% alcohol. After another 12–24-hr period the dehydration is practically complete, but removal of the disc, followed by one or two changes of 100% alcohol at intervals of 2–4 hrs, is advised in the interest of safety.

(12) To the dehydrated tissues in 1 ml of 100% alcohol is added 4 ml of melted paraffin which has cooled to the point where it will partly solidify upon coming into contact with the alcohol at room temperature. There seems to be no injury to root tips occasioned by failure to pass them through pure normal butyl alcohol to eliminate the balance of the ethyl alcohol, and it has been determined experimentally that small amounts of the latter are soluble in paraffin at the usual oven temperatures.

(13) The unstoppered vial is now placed in the paraffin oven for a 24-hr period. After two or more changes of pure paraffin at intervals of 4–24 hrs, the tissues are embedded in the conventional manner in fresh, filtered paraffin containing no traces of alcoholic impurities.

The method just described has been used very successfully for classroom work in the preparation of slides for chromosome studies on a number of different plant species. If the sides of the paraffin block are shaved closely to the root tip bundle, it is usually possible to mount the entire meristematic portion under a 22-mm by 50-mm coverslip, provided the sections are not thinner than 10 μ. Sections thinner than 10 μ are usually undesirable because too many division figures are destroyed by cutting. The initial steps of diffusion-dehydration will doubtless find a wide application in biological microtomy.

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Effect of Acetone and Alcohol Fixation and Paraffin Embedding on Activity of Acid and Alkaline Phosphatases in Rat Tissues[1]

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In the course of research involving studies of phosphatase activity in animal tissues, it became of interest to determine quantitatively how much of the enzyme activity present in fresh tissue is preserved in the technical processes of Gomori's histochemical methods (*3*, *4*) for acid and alkaline phosphatases.

It is known that it is more difficult to demonstrate acid phosphatase (AcP-ase) histochemically than alkaline phosphatase (AlP-ase) and that acetone fixation gives better preservation of AcP-ase activity than alcohol. The effect of fixation and embedding on the cytological localization of AlP-ase has been studied in tissue sections by Danielli (*1*) and Emmel (*2*). The only quantitative data on the effect of fixation are those of Gomori (*4*), who showed that alcohol destroys AcP-ase but causes only 20% inactivation of AlP-ase, and those of Danielli (*1*), who estimated that paraffin embedding causes a 75% loss of activity of AlP-ase. To obtain more complete quantitative data on the effects of fixatives and embedding on

[1] Supported in part by the Research Committee of the Graduate School from funds supplied by the Wisconsin Alumni Research Foundation, administered by R. K. Meyer and W. H. McShan, and by a grant from the Committee on Growth, National Research Council, administered by E. T. Engle.

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both AcP-ase and AlP-ase, the experiments described below were performed.

Enzyme activity was measured in (a) pieces of tissue freshly removed from the animals, (b) pieces fixed for varying times in acetone and alcohol, and (c) pieces subjected to fixation, embedding in paraffin, sectioning, and deparaffinizing. The method for determination of phosphatase activity was that of Huggins and Talalay (*5*), modified as reported previously (*6*).

The tissues on which data were obtained were liver, kidney cortex, and duodenum of albino rats. An attempt was made to study uterus as well, but values obtained were too small to be of significance. The tissues were removed as rapidly as possible after the animals had been killed; small pieces of the selected tissues were weighed to the nearest milligram and dropped into chilled absolute acetone and 80% ethyl alcohol. One unfixed

TABLE 1

Tissue and fixative	Percentage of original activity remaining								
	AcP-ase					AlP-ase			
	7 hrs	28 hrs	50 hrs	72 hrs	Embedded	28 hrs	50 hrs	72 hrs	Embedded
Alcohol									
Kidney	38	22	23	37	12	63	95	92	31
Liver	20	14	17	16	2	..	..	..	..
Duodenum	..	..	..	..	..	86	82	90	8
Mean	29	18	20	26	7	74	88	91	20
Acetone									
Kidney	35	24	20	43	3	52	66	77	34
Liver	22	17	25	37	6	..	..	..	..
Duodenum	..	..	..	..	..	90	64	50	24
Mean	28	20	22	40	4	71	65	64	29

piece of each tissue was transferred directly to a glass homogenizing tube for the fresh tissue determination. Phosphatase determinations were made on these unfixed tissues within 1 hr after removal from the animals. Values for the fixed tissues were determined after 7, 28, 50, and 72 hrs of refrigerated storage in the fixative.

After 48 hrs of storage, one piece of each tissue was removed from the fixative. The alcohol-fixed tissues were dehydrated with 95% and absolute alcohol, then transferred to xylene; the acetone-fixed tissues were transferred directly to xylene. They were then subjected to the following treatment: xylene, 30 min; xylene, 30 min; paraffin, 60 min at 56° C; paraffin, 60 min at 56° C; paraffin embedding; sectioning at 30 μ. The sections were transferred to xylene, the xylene decanted, washed once with xylene, twice with absolute alcohol, and once with distilled water.

The tissues, fixed and/or embedded as described above, were then homogenized and run through the Huggins-Talalay determinations in the same manner as the fresh tissues. AcP-ase and AlP-ase unitage was calculated, and the values, expressed as units[4]/100 mg of the fresh weight of the tissue, were converted to percentages of the fresh tissue values.

Since the AlP-ase of liver was of too small concentration to give interpretable values, the values reported here are for the AlP-ase of kidney and duodenum and the AcP-ase of liver and kidney. The tissues of two animals were used in each series of determinations. The data obtained are presented in Table 1 and summarized graphically in Fig. 1. No values are reported for 7 hrs fixation of AlP-ase because the values obtained for this short period were so variable as to be utterly without significance. Apparently the variation in degree of penetration of the fixative, diffusion of ions, and other unknown factors was great enough at this stage of the process to cause these extremely divergent results.

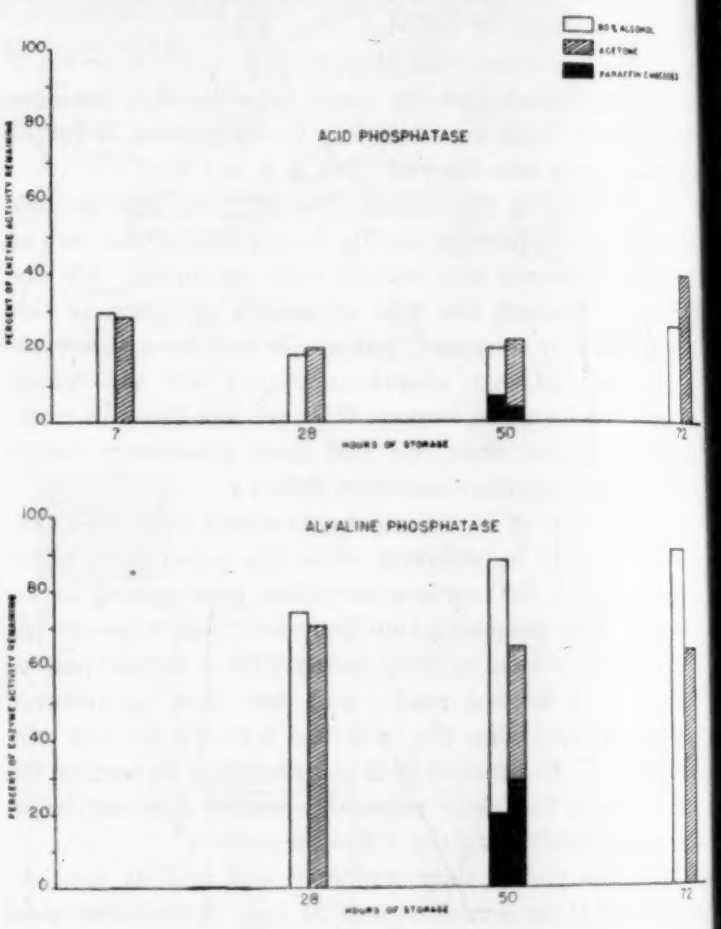

FIG. 1

The data for AcP-ase show why histochemical demonstration of this enzyme is frequently difficult. The fixation destroys 70–80% of the original enzyme activity of the tissue in 80% alcohol and 60–80% of the activity in absolute acetone. The process of clearing, embedding, and sectioning destroys most of the activity remaining in the fixed tissue, so that by the time the tissues are ready for incubation with the substrate the activity is reduced to a mean of about 5% of the original value. It should be noted that in most cases AcP-ase survived acetone fixation to a somewhat greater extent than alcohol fixation. The great reduction inherent in the embedding and associated procedures seems to be about equally destructive of either acetone-fixed or alcohol-fixed enzyme.

The data for AlP-ase demonstrate that the inactivation

[4] Ten phosphatase units is that amount of enzyme which will liberate the colorimetric equivalent of 1 mg of phenolphthalein from an excess of sodium phenolphthalein phosphate in 1 hr at 37° C at pH 5.4 or 9.7.

by the fixatives is not nearly so great as that of AcP-ase, and again a differential between the two fixatives exists. Whereas acetone fixation inactivates the original enzyme by 30–35%, alcohol destroys only 10–25% of the activity. In so far as alcohol is concerned, this confirms the findings of Gomori mentioned above (*3*). Here, as in the case of the AcP-ase, the bulk of the loss of enzyme occurs in the processes attendant upon embedding and sectioning, since an over-all loss of 70–80% is found after these processes, confirming Danielli's observation (*1*).

Since this investigation was undertaken with purely technical objectives, no attempt has been made to determine the cause of the behavior of these tissue enzymes during microtechnical procedures. Undoubtedly, a study of such factors as magnesium ion diffusion in relation to the type of fixative and to the size of the block of tissue, physical structures of the different tissues, and length of exposure to high temperature in the paraffin oven would result in data that might contribute to the explanation of the mechanisms involved, but such studies are beyond the scope of this paper.

From these data it may be concluded that (1) AcP-ase is inactivated by both acetone and alcohol fixation to a far greater extent than AlP-ase; (2) alcohol fixation preserves a somewhat greater amount of AlP-ase activity than does acetone fixation; and (3) the enzyme activity remaining in paraffin-embedded tissue sections is approximately 5% in the case of AcP-ase and 20–30% in the case of AlP-ase.

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A Simple Stereoscope for Viewing Double-Lens Camera Stereographs Without Transposition

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A single-film stereograph taken with a double-lens stereoscopic camera may be viewed qualitatively in correct perspective through the use of the stereoscope described herein, which accomplishes the necessary transposition of the two images by optical means. Therefore, the stereoscopic images do not have to be transposed physically, as would be necessary if they were viewed with the usual stereoscope, and the original spatial relationship between the images is preserved for any subsequent quantitative distance-measurements that might be made from the stereograph. Viewing such a stereograph with an ordinary stereoscope is to be avoided, since it results in a pseudoscopic view that is confusing under most circumstances (*1*).

A simple prism-stereoscope which has been built by the author for viewing untransposed stereographic transparencies is shown in schematic plan view in Fig. 1. A suitable light source (A) and a diffusing screen of translucent glass (B) provide uniform illumination for the untransposed stereograph (C). This is viewed by the observer (G) through the lenses (D) and the prisms (F). In the prism-stereoscope built for viewing stereographs taken on 35-mm color film with 2½″ separation, the lenses are planoconvex, and each has a diameter of 3″ and a focal length of 4½″. The lenses are cut and placed together about 1″ in front of the stereograph so that they provide complete enlarged virtual images of both views.

Fig. 1

To effect the necessary image transposition, by making the right eye of the observer see the left picture of the stereoscopic pair and vice versa, two 10-diopter deviation prisms are mounted about 12″ from the transparency. A mask (E) is interposed so that the right transparency is blocked from view by the right eye and the left transparency is not visible to the left eye. Since the glass-mounted stereograph is flat and each picture is viewed at an angle with this arrangement, a small amount of keystone distortion is present on the upper and lower margins of the pictures. This can be corrected by tilting the joined sections of the two lenses slightly away from the stereograph, as indicated in Fig. 1. The inside of the housing box (not shown) should be painted white in the region of A and B and dull black elsewhere. The stereograph (C) is inserted through a slot that provides for proper positioning of the images.

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Book Reviews

Fisiologia del trabajo humano (Physiology of human work). Amadeo Herlitzka. (Trans. into Spanish by Diego A. de Santillan.) Buenos Aires: Editorial Americalee, 1945. Pp. 781. (Illustrated.) $12.00 (U. S.).

In the 19th Century, physiology was concerned for the most part with the human organism in rest, at "room temperature," and close to the sea level. Inclusion of activity, and also of temperature and altitude, as variables modifying bodily functions widened significantly the scope of human physiology, presenting the research workers with a host of problems arising in the context of occupational work (industrial, aviational, military physiology), athletics, and sports.

Herlitzka's book is a *magnum opus* written by an investigator who for 50 years was engaged in active research on problems of human work and human "fitness." The first 200 pages deal with general muscle physiology and are followed by the discussion of the mechanics of movement, the processes taking place in an active muscle, and muscular fatigue. A chapter is devoted to the microanalysis of the spatiotemporal characteristics of movements. There is a section concerned with the energetic aspects of human work, including mechanical work efficiency, and with the related problems of human nutrition. One hundred pages are given to the description of functional changes accompanying muscular work: the respiratory and circulatory phenomena, changes in blood composition and water exchange, and the less extensively studied effects of physical work on the nervous system and the special senses. The fifth section, covering another 200 pages, is concerned with factors which modify the response of the organism to physical work: individual differences in fitness, differences related to sex and age, effects of training, influence of environmental factors at work and of climate in general, pharmacological agents, and the effects of the physical activity itself, such as adaptation during the course of work.

The last part of the book is devoted to industrial physiology. Scientific management, worthy of its name, includes logically a scientific determination of the conditions optimal for the adjustment between the worker and his work. This is a physiotechnological problem, involving, on the one hand, adjustment of the human factor, through selection and training, to the demands of the machine and, on the other hand, modification of the industrial environment (temperature, humidity, air circulation, illumination), the work place and tools (form, dimensions, weight, placement), and the work methods (pattern and speed of movements, duration and location of rest pauses) in a way which would make possible a high productivity without adverse effects on the health of the worker. Unfortunately, the treatment of these problems is sketchy. The author had little direct contact with manufacturing industry, and the discussion is based largely on his experience in aviation physiology.

The book as a whole is a mature summary of the physiology of activity, with emphasis on the fundamental aspects of human work. It makes available the results of studies, especially by Russian and Italian investigators, which are otherwise inaccessible. Physiologists, psychologists, physical educators, time-and-motion engineers, and industrial physicians will find Herlitzka's tome a valuable source of information, logically organized and critically evaluated.

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Coating and ink resins: a technological study. William Krumbhaar. New York: Reinhold, 1947. Pp. v + 318. (Illustrated.) $7.00.

This book is a very useful and authoritative practical guide to the properties and uses of the light-colored, hard, soluble, and high-viscosity groups of phenolic, maleic, and copal-type synthetic resins. The scope of the book is limited to those commonly-used resin types with which the author is most familiar, and the discussions are based on practical experience only.

No chemical equations or structural formulas are included. The theoretical consideration of the chemistry and physics of the resinous materials is confined to those conceptions which can be supported by experimental evidence. Detailed descriptions of several methods of chemical analysis are presented, notable among which are a refined method of determining molecular weights by the freezing-point depression of diphenylamine and the use of the oxygen bomb to measure oxidation resistance.

In the chapter on "Influence of Resins on Surface Coatings," Dr. Krumbhaar clearly brings out the effect on the properties of the final surface-coating material produced by varying resin content, type, viscosity, solubility, etc.

The chapter on "Influence of Resins on Printing Inks" contains an excellent discussion of the relationship between resin characteristics and livering, tack, penetration, gloss, bronzing, mechanical properties, and chemical stability.

Interesting chapters on mechanical equipment and a concise discussion of the patent situation are also presented.

The inclusion of subheadings as part of the script is confusing to some extent, because the subheadings do not always define the subject being discussed.

The reviewer highly recommends this book to all persons interested in ink, paint, and varnish technology.

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